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PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

178
577 D1/D2
SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Serial Number ____________

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CHANGE INFORMATION

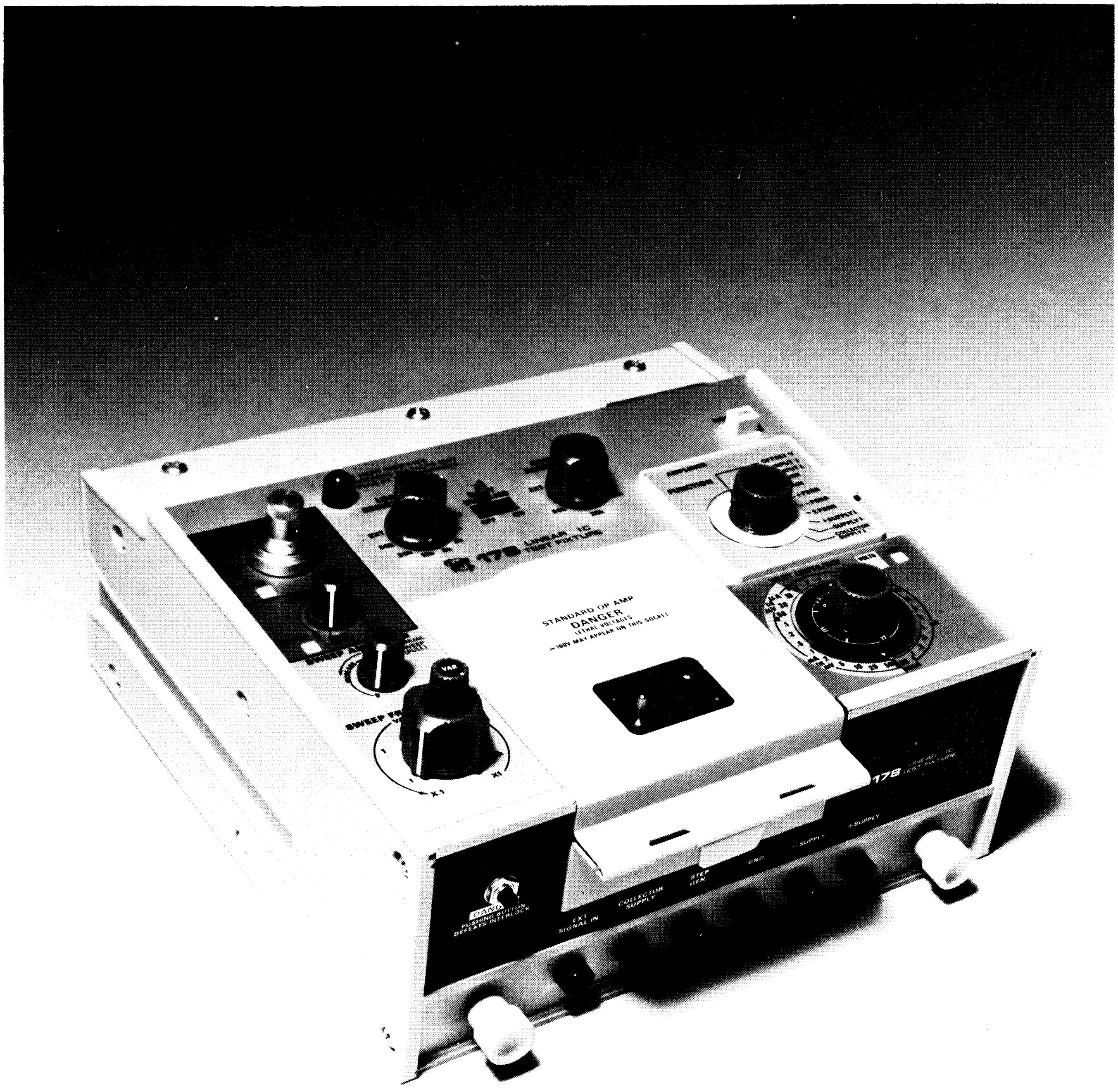

1474-03

Fig. 1-1. 178 Linear Integrated Circuit Test Fixture.

SPECIFICATION

Introduction

The 178 Linear IC Test Fixture is a plug-in device for use with the 577-D1 or 577-D2 Curve Tracer Systems. The 577-178 combination, with the D1 Display Unit module, is designed to measure the parameters of operational amplifiers, comparators, differential amplifiers, and regulators. The D2 Display Unit may be used, but lacking display storage, the results may not be satisfactory because of the low frequencies necessary to test many devices.

The 178 Linear IC Test Fixture features a sweep generator, positive and negative supplies, part of the vertical measuring system, a feedback loop for the Device Under Test (DUT), and switching capabilities to facilitate testing of various parameters under diverse conditions.

The sweep generator provides a variable frequency, 0.01 Hz to 1 kHz sinusoidal output. This output is used to force the DUT output or the positive and negative supplies (either in-phase or out-of-phase), or to sweep the DUT inputs.

The dc voltage levels of both positive and negative supplies are independently adjustable from 0 to 30 volts. The negative supply amplitude can be made to track (have the same absolute value as) the positive supply amplitude. The maximum current capability of the positive and negative supplies can be limited by potentiometers on the DUT card. If the load current attempts to exceed the set limits, the supply current limits and a lamp for each supply indicates the condition.

Any pair (of four pairs) of internal source resistors can be used in series with the amplifier inputs. Any value of external source resistance can be added to the DUT card. The DUT output can be loaded with one of seven values of internal load resistance. Any value of external load resistance can be added to the DUT card in parallel with the 50 kΩ of resistance provided on the card.

The vertical measurement system is capable of measuring either voltage or current. The choice of voltage or current measurement is determined by the position of the FUNCTION switch and is indicated by the AMPS or VOLTS lamp.

The vertical deflection factor switch has 28 positions ranging from 50 p/Div to 50 m/Div (unmagnified) in a 1-2-5 sequence. All 28 positions are used for current measurements, but only the range from 10 μ/Div to 50 m/Div can be used for voltage measurements. Any attempt to measure voltage using vertical deflection factors less than 10 μV/Div (unmagnified) causes the VOLTS indicator light to turn off, indicating an unusable switch position.

Vertical deflection factor is increased by ten when the Vertical POSITION X10 VERT MAG knob on the 577 is pulled to the outward position; the increase is indicated by the lamp behind the VERT UNITS/DIV knob skirt. This lamp also turns off if an unusable switch position is selected.

A FUNCTION selector switch provides eleven test positions. All positions are useful to test operational amplifiers.

Horizontal deflection factors range from 50 mV/Div to 200 V/Div (unmagnified), and are selected from the COLLECTOR VOLTS segment of the 577 HORIZ VOLTS/DIV switch.

The Standard Op Amp card can be used to test single, dual, and quad operational amplifiers. It can also be used to test single and dual comparators and differential amplifiers. Regulator cards are used to test three-terminal regulator parameters. These regulator cards are optional accessories and are covered on separate data sheets. IC socket-pin configurations must be connected to the cards by using adapter sockets and patch cords.

An offset ZERO button provides a zero crt display reference and nulls offset voltage for certain measurements that would otherwise be off screen. Offset is usually reset automatically when the setting of the FUNCTION switch is changed. Offset must be reset manually when switching between 1 and .5 mV/DIV and between .1 mV and 50 μV/DIV.

The stored display on the D1 Display Unit is erased whenever the FUNCTION switch is changed, except when switching between +INPUT I and −INPUT I, +PSRR and −PSRR, and +SUPPLY I and −SUPPLY I.

The electrical characteristics in the following table are valid only if the instrument has been calibrated at an ambient temperature between +20° C and +30° C, and the instrument is operating at an ambient temperature between 0° C and +50° C (unless otherwise noted).

Items listed in the Performance Requirements column of the Electrical Characteristics are verified by completing the Performance Check in this manual. Items listed in the Supplemental Information column are not verified in this manual; they are either explanatory notes or performance characteristics for which no limits are specified.

Table 1-1

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Vertical Deflection Factors		
Input Current (In +Input I and −Input I Functions	50 pA/DIV to .2 mA/DIV in a 1-2-5 sequence, unmagnified. 5 pA/DIV to 20 µA/DIV with 10X magnifier on.	
Accuracy[a]	Within ±3% ±50 pA, unmagnified. Within ±4% ±50 pA with 10X magnifier on.	
Voltage[b]	10 µV/DIV to 50 mV/DIV in a 1-2-5 sequence, unmagnified. 1 µV/DIV to 5 mV/DIV with 10X magnifier on.	
GAIN and OFFSET V Functions Accuracy[a]	Within ±3%, unmagnified; ±4% with 10X magnifier on.	
CMRR Function Accuracy	Within ±3% + $\frac{100K}{\text{Gain} - K}$ % + $\frac{150}{K}$ $\mu V/V_{cm}$ Within ±4% + $\frac{100\ K}{\text{Gain} - K}$ % ± $\frac{150}{K}$ $\mu V/V_{cm}$ with 10X magnifier on (1 µV/DIV to 5 µV/DIV, see footnotes b and c).	
PSRR Function Accuracy	Within ±3% + $\frac{100K}{\text{Gain} - K}$ % Within ±4% + $\frac{100\ K}{\text{Gain} - K}$ % with 10X magnifier on (1 µV/DIV to 5 µV/DIV; See footnotes b and c).	

[a] Accuracies are the highest percentage of on-screen values.

[b] Vertical magnification is not recommended for .5 mV/DIV through 50 mV/DIV unmagnified settings.

**[c] DUT gain with small voltage signal out near zero with 50 kΩ load:
K = 10 for 50 mV/Div to 1 mV/Div, K = 100 for .5 mV/Div to 100 µ/Div, and K = 1000 for 50 µV/Div to 10 µV/Div. Vcm = Common-mode voltage.**

Table 1-1 (cont)

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Power Supply		
Current	1 nA/DIV to 50 mA/DIV in a 1-2-5 sequence, unmagnified. 0.1 nA/DIV to 5 mA/DIV with 10X magnifier on.	
Current Mode Accuracy[a]	Within ±3% ±1 nA unmagnified; +4% ±1 nA with 10X magnifier on.	
Collector Supply		
Current	1 nA/DIV to 50 mA/DIV in a 1-2-5 sequence, unmagnified. 0.1 nA/DIV to 5 mA/DIV with 10X magnifier on.	
Current Mode Accuracy[a]	Within ±3% ±1 nA, unmagnified. ±4% ±1 nA with 10X magnifier on.	
Positive and Negative Supplies		
Voltage	Adjustable from 0 to 30 V.	Both supplies can be adjusted from the +SUPPLY control. Negative supply can be independently adjusted using the uncalibrated −SUPPLY control.
Accuracy	Within ±2% ±100 mV.	The −SUPPLY voltage is within ±1% (absolute) of the +SUPPLY voltage when the −SUPPLY control is in the TRACK +SUPPLY position.
Current	At least 150 mA	Adjustable current limiting.
Sweep Generator		
Frequency	0.1 Hz to 1 kHz, sinusoidal signal. Five ranges, 0.1, 1, 10, 100, and 1000 Hz with X.1 to X1 variable.	Ranges overlap at X.1 end of variable.
Accuracy	Within ±5% in calibrated (X1) position.	
Amplitude		
In OFFSET AND GAIN Functions	Adjustable from 0V to 30 V ±3% maximum peak	Adjustable, depends on function. The voltage should be limited to the output capability of the DUT.
Common-mode Voltage in INPUT I and CMRR Functions	0 V to 30 V ±3% maximum peak. In the 1 mV/DIV to 50 mV/DIV ranges, the values are 10% lower.	Limited to the power supply voltages (clipped)
Power Supply Voltage in PSRR and SUPPLY I Functions		See Positive and Negative Supplies
Manual Sweep		The Generator output may be manually set to any dc level (uncalibrated) within its amplitude range (depends on the setting of the FUNCTION switch).

[a] Accuracies are the highest percentage of on-screen values.

Table 1-1 (cont)

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirement	Supplemental Information
Source Resistance		
Resistances		Four pairs; 50 Ω, 10 kΩ, 20 kΩ, and 50 kΩ. When the VERT UNITS/DIV switch is set to 1 mV/DIV through 50 mV/DIV, the indicated values increase by 500 Ω. External resistors can be used.
Tolerance		±1% ±10 Ω.
Load Resistance		
Resistances		Seven Resistances; 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, and 50 kΩ.
Tolerance		±3% except when using the 50 mV, 20 mV, and 10 mV positions of the VERT UNITS/DIV switch. The tolerance for the 50 kΩ then becomes ±30%, for the 20 kΩ ±14%, 10 kΩ ±7%, and 5 kΩ ±3% when the DUT output voltage swing is 2.5 V or less. The maximum tolerance decreases exponentially as the output swing is increased and is less than ±3% when the output is swinging ±30 volts.

Table 1-2

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental
Temperature		
Specified Operating		+10° C (+50° F) to +40° C (+104° F)
Useful Operating		0° C (+32° F) to +50° C (+120° F)
Non-operating		−40° C (−40° F) to +65° C (+149° F).
Altitude		
Operating		To 10,000 feet (3000 metres)
Transportation		12-inch (30 cm) package drop. Qualified under the National Safe Transit Committee procedure 1A.

Table 1-3

PHYSICAL CHARACTERISTICS

Dimensions	
Height	4.5 inches (11.4 cm)
Width	7.9 inches (20.1 cm)
Depth	7.8 inches (19.8 cm)
Weight	
Net	3.3 pounds (1.5 kg)

STANDARD ACCESSORIES

Refer to the Replaceable Mechanical Parts list for a listing of the standard accessories.

OPERATING INFORMATION

Introduction

The 178 Test Fixture operates with a TEKTRONIX 577 Curve Tracer and the D1 or D2 Display Unit as a system.

This section of the manual gives a brief functional description of the front-panel controls of the 178. See the 577—178—D1 or D2 Operators Manual for a complete operating procedure.

Preliminary

For initial preparation, refer to the Operating Instructions section of the 577—178—D1 or D2 Operators Manual. The Operators Manual contains operating instructions, as well as general and specific application information.

CONTROLS

This is a brief description of the functions of the front-panel controls. More detailed information is given in the Operators Manual.

FUNCTION Selector

The eleven-position FUNCTION switch selects the points to be monitored by the vertical and horizontal display axes, and selects the point driven by the Sweep Generator.

SWEEP FREQUENCY

Adjusts the Sweep Generator frequency from .01 Hz to 1 kHz. Five calibrated frequency steps, .1, 1, 10, 100, and 1 kHz, are provided. The VARIABLE control provides continuous adjustment from .1 to 1.0 times the selected decade value.

SWEEP AMPLITUDE

Adjusts the Sweep Generator amplitude from zero volts to its maximum value (which depends on the function being swept by the Sweep Generator).

+SUPPLY, −SUPPLY

There are two adjustable, regulated supplies, one positive and one negative, in the 178. The adjustment range is 0 to 30 volts, with 150 mA current capability. Adjustable current limiting for each supply is provided on the Device Card. Overload lamps in the supply-control area indicate when the current limit is reached.

SOURCE RESISTANCE

This switch selects one pair of four input resistors pairs: 50 Ω (550 Ω when VERT UNITS/DIV is in the 1 mV to 50 mV/DIV range), 10 k, 20 k, or 50 k. External resistances may be selected in the EXT position.

LOAD RESISTANCE

This switch selects one of seven load resistors: 100 Ω, 1 k, 2 k, 5 k, 10 k, 20 k, or 50 k. External resistance may be selected in the EXT position.

VERT UNITS/DIV

This switch selects the vertical deflection factor. The deflection factor is either voltage or current per division, depending on the FUNCTION switch position. Indicator lamps show either VOLTS or AMPS. The voltage measurement range is 10 μV/DIV to 50 mV/DIV (μV/DIV with X10 vertical magnifier on). The current measurement range is 50 pA/DIV to 50 mA/DIV (5 pA/DIV with X10 vertical magnifier on).

DEVICE CARD

The Device Card provides test configurations most suited to several classes of devices. Device Cards provide a means of making electrical connections to the DUT (device under test), and in most cases, also provide some circuitry.

IDENTIFICATION OF CONTROLS

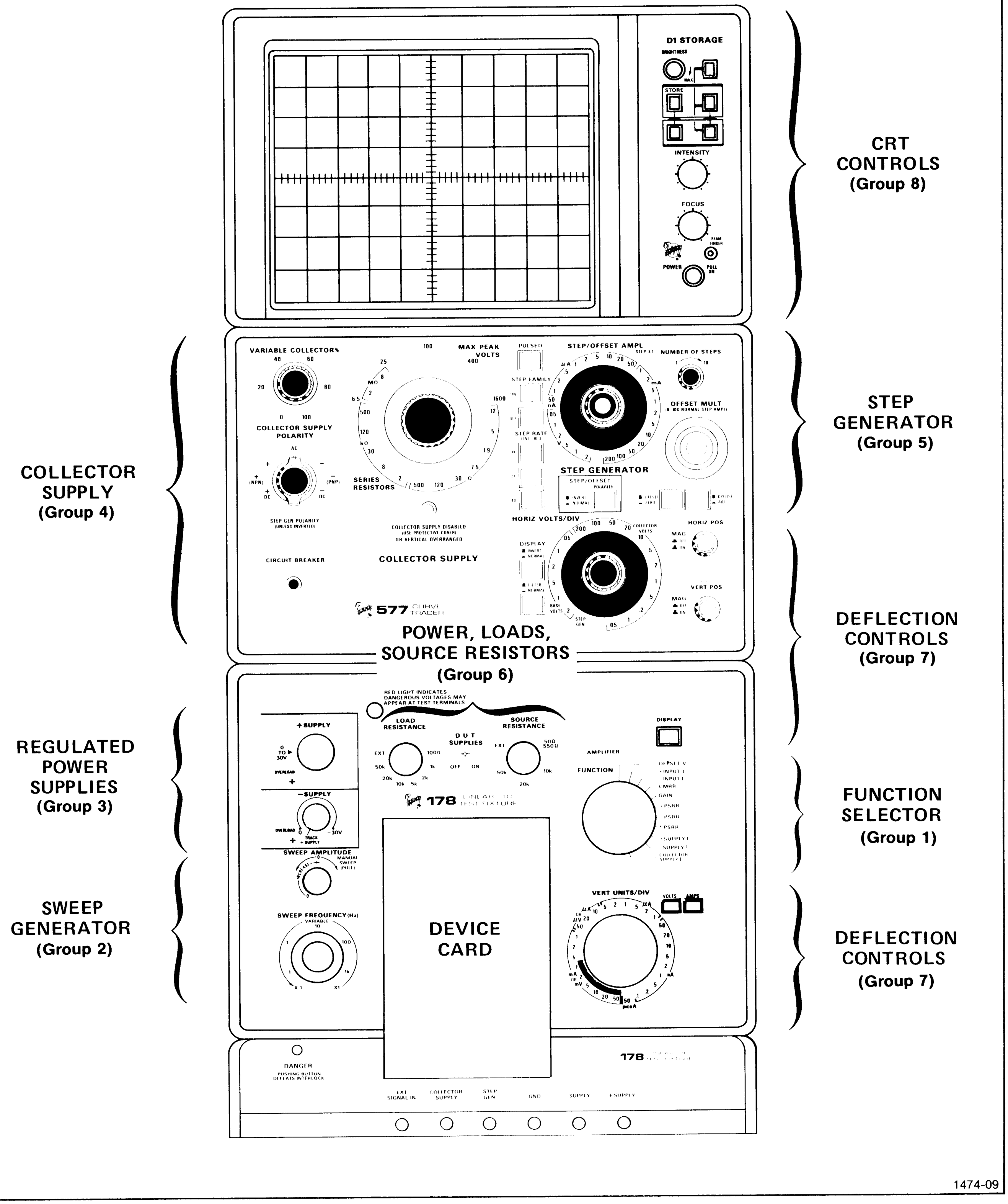

D1 STORAGE
BRIGHTNESS
STORE
INTENSITY
FOCUS
BEAM FINDER
POWER
PULL ON
CRT CONTROLS (Group 8)
VARIABLE COLLECTOR%
COLLECTOR SUPPLY POLARITY
MAX PEAK VOLTS
SERIES RESISTORS
STEP GEN POLARITY (UNLESS INVERTED)
COLLECTOR SUPPLY DISABLED (USE PROTECTIVE COVER) OR VERTICAL OVERRANGED
CIRCUIT BREAKER
COLLECTOR SUPPLY
577 CURVE TRACER
PULSED
STEP/OFFSET AMPL
NUMBER OF STEPS
STEP FAMILY
STEP RATE
OFFSET MULT
STEP GENERATOR
STEP/OFFSET POLARITY
HORIZ VOLTS/DIV
DISPLAY
HORIZ POS
VERT POS
COLLECTOR SUPPLY (Group 4)
STEP GENERATOR (Group 5)
DEFLECTION CONTROLS (Group 7)
POWER, LOADS, SOURCE RESISTORS (Group 6)
RED LIGHT INDICATES DANGEROUS VOLTAGES MAY APPEAR AT TEST TERMINALS
LOAD RESISTANCE
SOURCE RESISTANCE
DUT SUPPLIES
+SUPPLY
−SUPPLY
OVERLOAD
TRACK +SUPPLY
SWEEP AMPLITUDE
MANUAL SWEEP (PULL)
SWEEP FREQUENCY (Hz)
VARIABLE
178 LINEAR IC TEST FIXTURE
DISPLAY
AMPLIFIER
FUNCTION
VERT UNITS/DIV
VOLTS
AMPS
DEVICE CARD
REGULATED POWER SUPPLIES (Group 3)
SWEEP GENERATOR (Group 2)
FUNCTION SELECTOR (Group 1)
DEFLECTION CONTROLS (Group 7)
DANGER PUSHING BUTTON DEFEATS INTERLOCK
EXT SIGNAL IN
COLLECTOR SUPPLY
STEP GEN
GND
−SUPPLY
+SUPPLY
178
1474-09

Fig. 2-1. 178 Front-panel controls.

CIRCUIT DESCRIPTION

This section of the 178 Service Manual contains the description of the 178 Linear Test Fixture. While using this description, refer to the illustrations within this section, and to the Switching Block Diagram and the circuit diagrams in the foldout pages at the rear of this manual.

The 178 Linear Test Fixture is designed to perform a multiplicity of tests, some of which differ widely. As a result, the circuit description is divided into two major parts, the Function Description and the Detailed Circuit Description. In the first, the 178 is described, for each function switch position, in the way the major circuits work together. In the second, each of the major circuits is described in detail.

FUNCTION DESCRIPTION

OFFSET VOLTS

Refer to Fig. 3-1. In this test, the Sweep Generator is fed in at the input of the Feedback Amplifier, forcing the Device Under Test (DUT) output. This is fed to and displayed by the Horizontal Amplifier. At the same time, the Vertical Amplifier displays the resultant differential voltage at the input terminals of the DUT. Note that the Sample & Hold Amplifier is not connected in the circuit; otherwise, the Sample & Hold circuit would have compensated for the differential voltage.

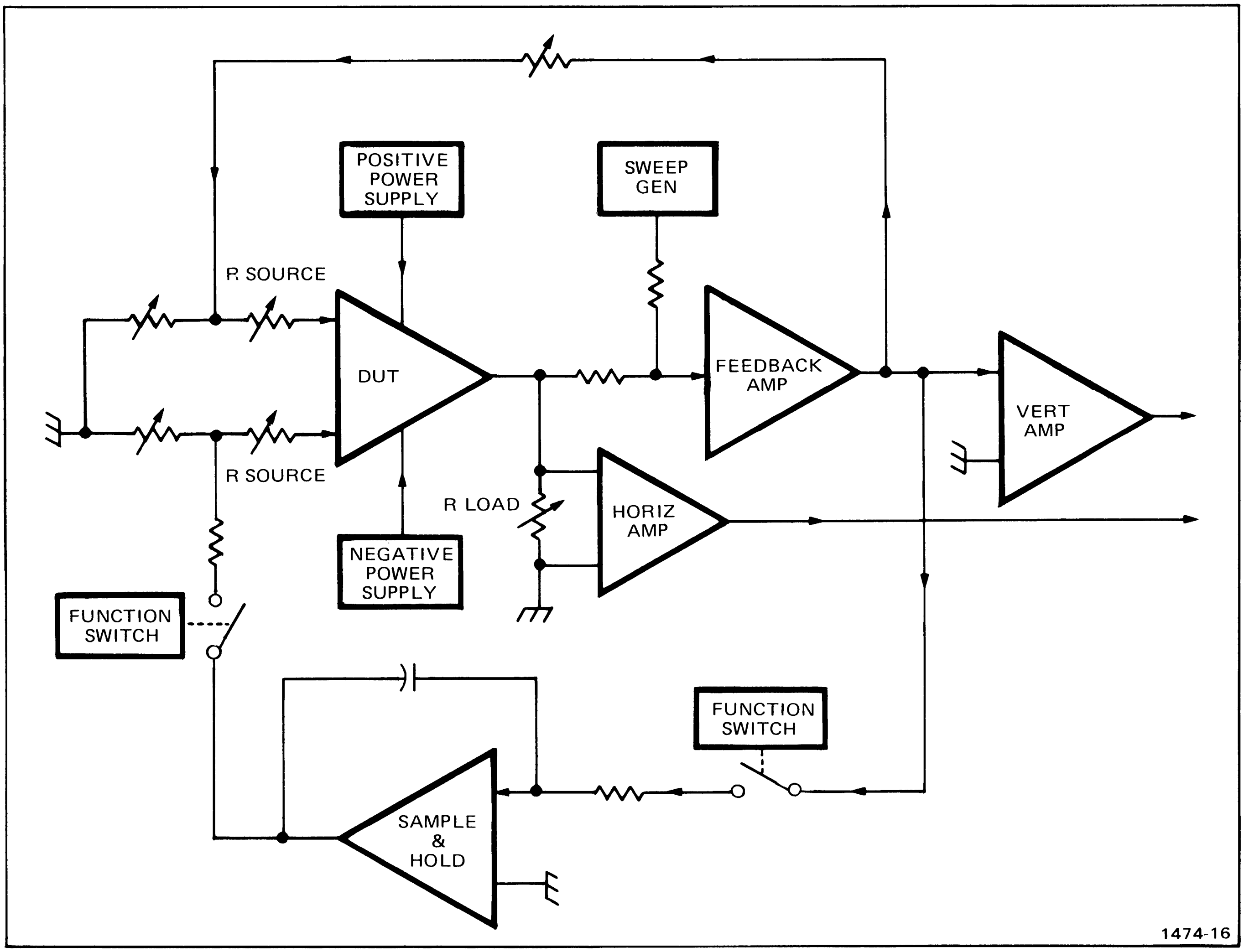

POSITIVE POWER SUPPLY
SWEEP GEN
R SOURCE
DUT
FEEDBACK AMP
VERT AMP
R SOURCE
R LOAD
HORIZ AMP
NEGATIVE POWER SUPPLY
FUNCTION SWITCH
FUNCTION SWITCH
SAMPLE & HOLD
1474-16

Fig. 3-1. Block diagram of OFFSET V configuration.

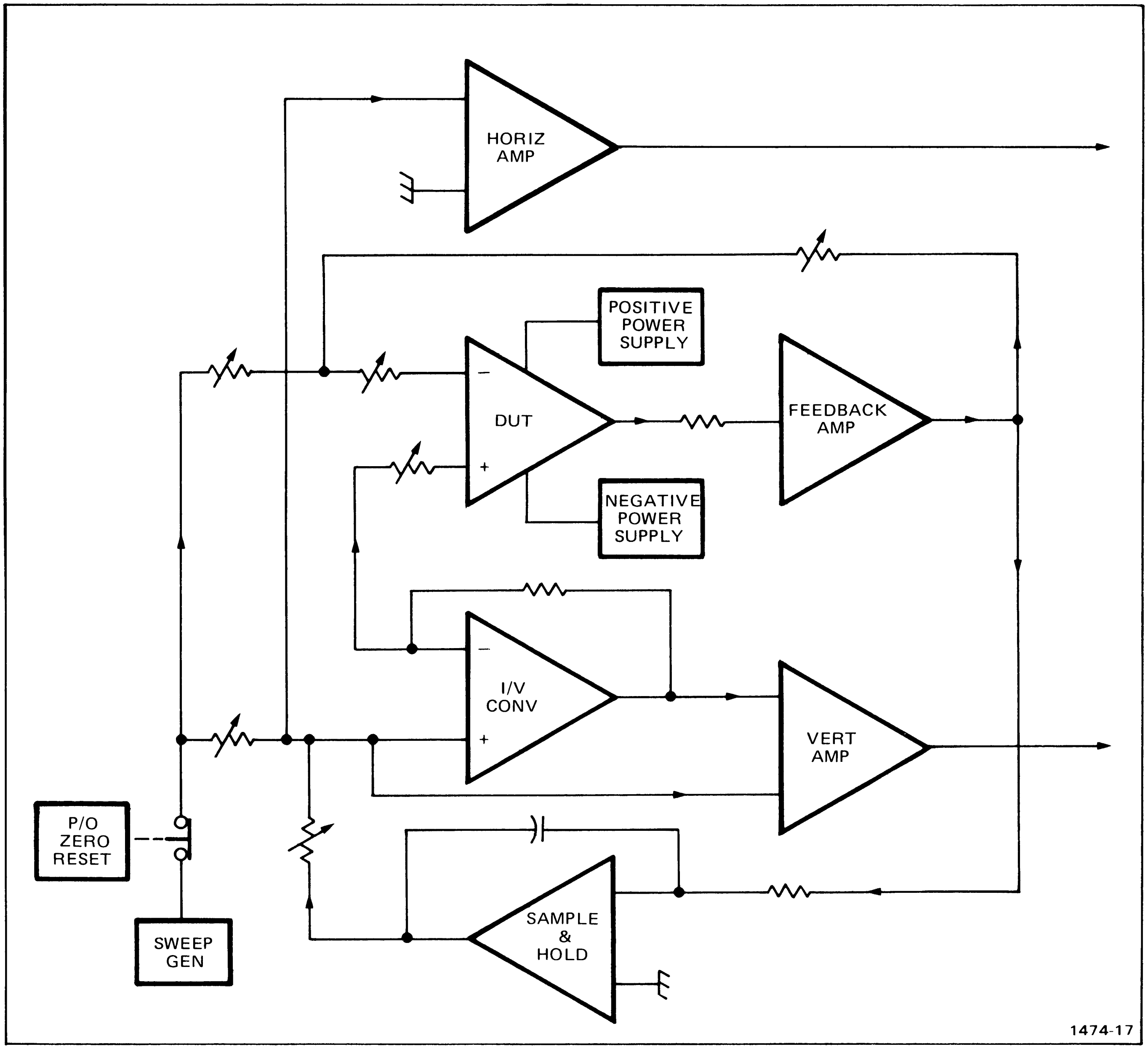

HORIZ AMP
POSITIVE POWER SUPPLY
DUT
FEEDBACK AMP
NEGATIVE POWER SUPPLY
I/V CONV
VERT AMP
P/O ZERO RESET
SWEEP GEN
SAMPLE & HOLD
1474-17

Fig. 3-2. Block diagram of + INPUT I configuration.

+ INPUT I

Refer to Fig. 3-2. In this test, the Sweep Generator provides a voltage to sweep the input of the DUT, while the input current to the DUT is measured. The swept voltage is displayed by the Horizontal Amplifier, and the resultant input current is first processed by the I/V Converter, then applied to the Vertical Amplifier for display on the vertical axis.

− INPUT I

Refer to Fig. 3-3. This test is exactly the same as the one for + INPUT I, except that the I/V Converter is tied to the opposite DUT input, permitting the measurement of the current at the minus input.

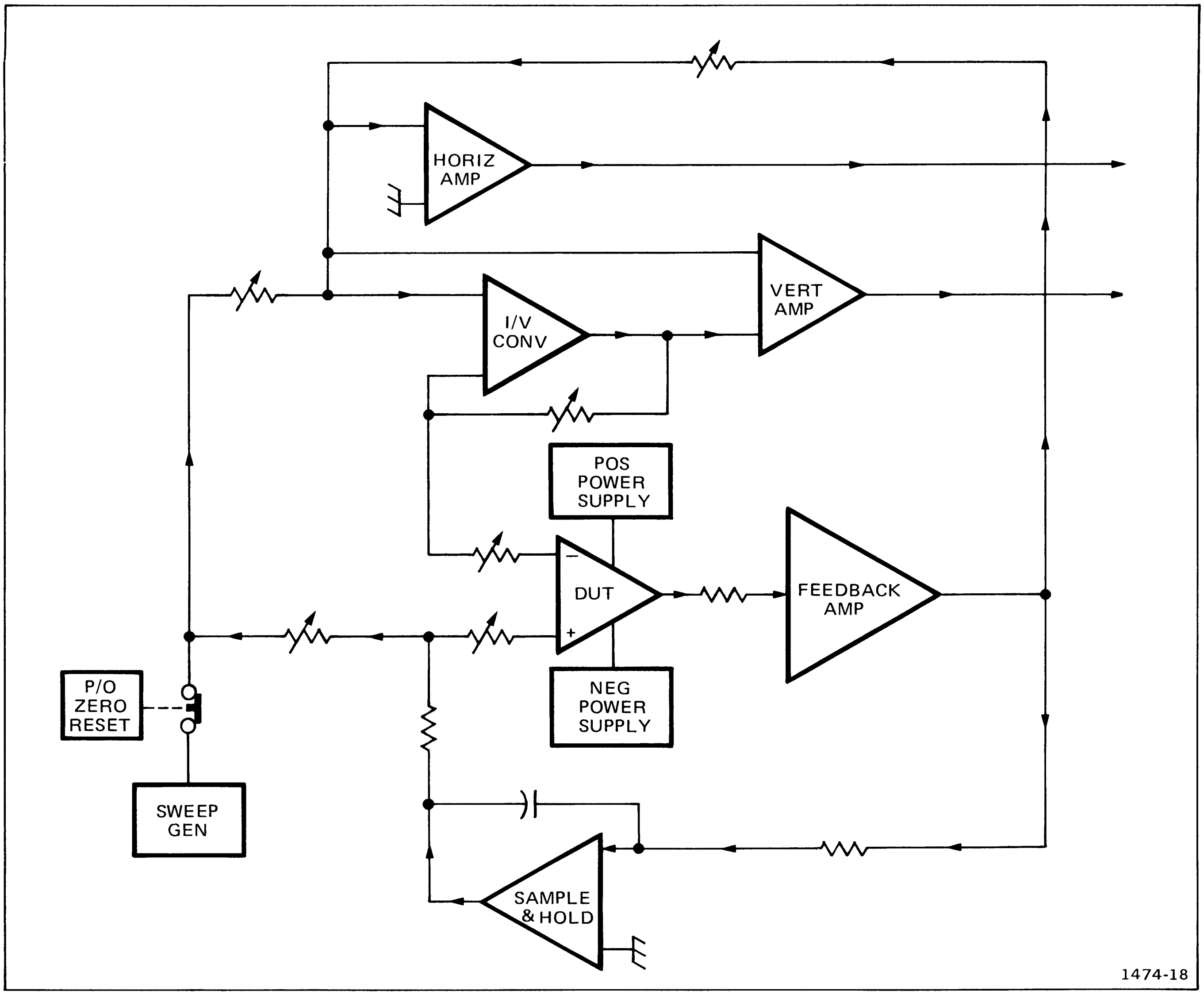

HORIZ AMP
VERT AMP
I/V CONV
POS POWER SUPPLY
DUT
FEEDBACK AMP
NEG POWER SUPPLY
P/O ZERO RESET
SWEEP GEN
SAMPLE & HOLD
1474-18

Fig. 3-3. Block diagram of − INPUT I configuration.

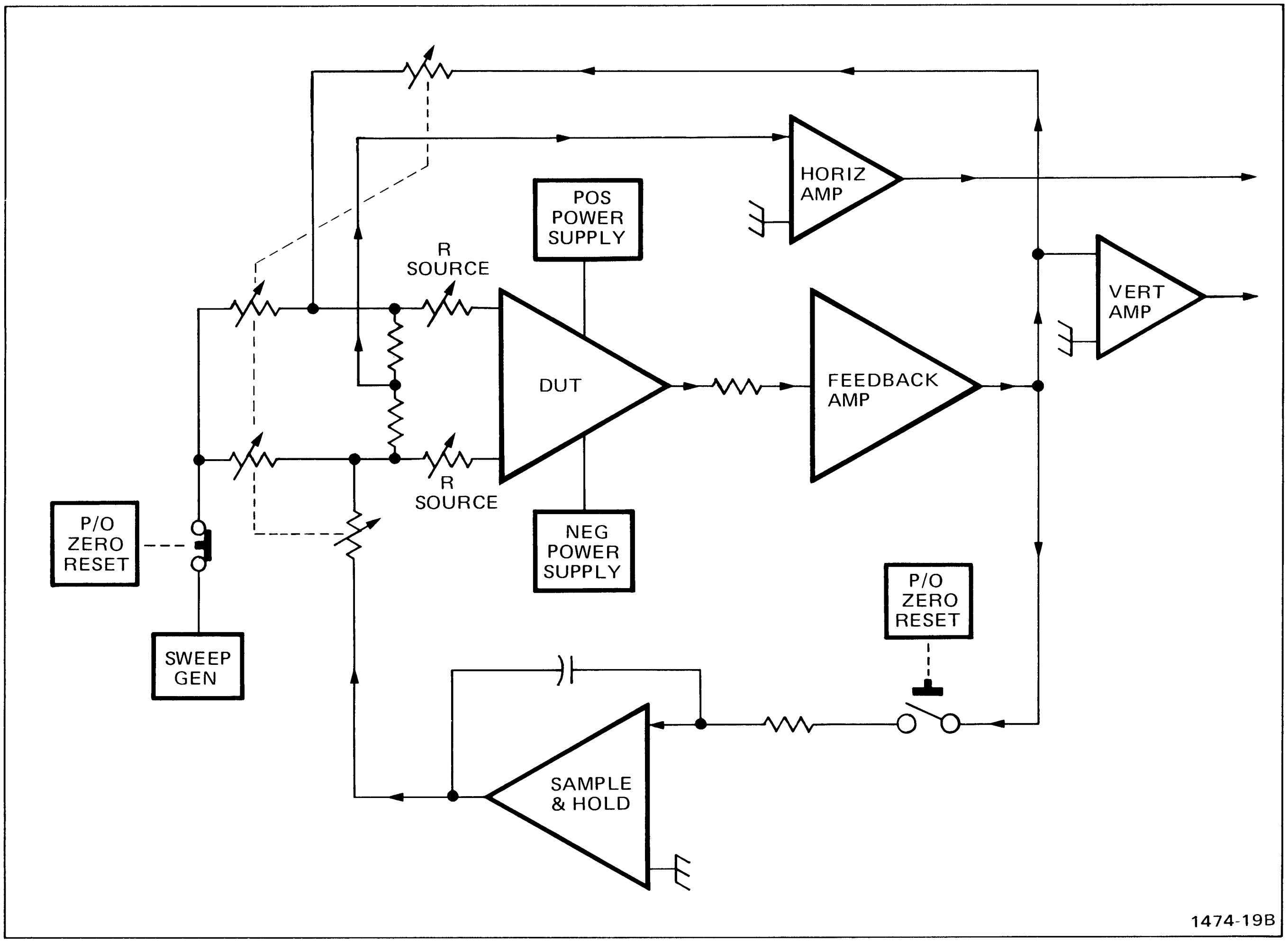

POS
POWER
SUPPLY
HORIZ
AMP
VERT
AMP
R
SOURCE
DUT
FEEDBACK
AMP
R
SOURCE
NEG
POWER
SUPPLY
P/O
ZERO
RESET
SWEEP
GEN
P/O
ZERO
RESET
SAMPLE
& HOLD
1474-19B

Fig. 3-4. Block diagram of CMRR configuration.

CMRR

Refer to Fig. 3-4. In the CMRR mode, the DUT inputs are tied together through attenuators, then a voltage is applied to the common junction of the attenuators from the Sweep Generator. The sweeping voltage is displayed on the horizontal axis. The resultant differential voltage that is fed back to the inputs from the Feedback Amplifier is displayed on the vertical axis.

GAIN

Refer to Fig. 3-5. The GAIN measurement configuration is similar to the OFFSET VOLTS configuration described earlier, except for the inclusion of the Sample & Hold Circuit. The Sweep Generator output is used to force the DUT output, which in turn is fed to the Horizontal Amplifier for display on the horizontal axis. The resultant differential voltage is fed to the vertical amplifier for display on the vertical axis.

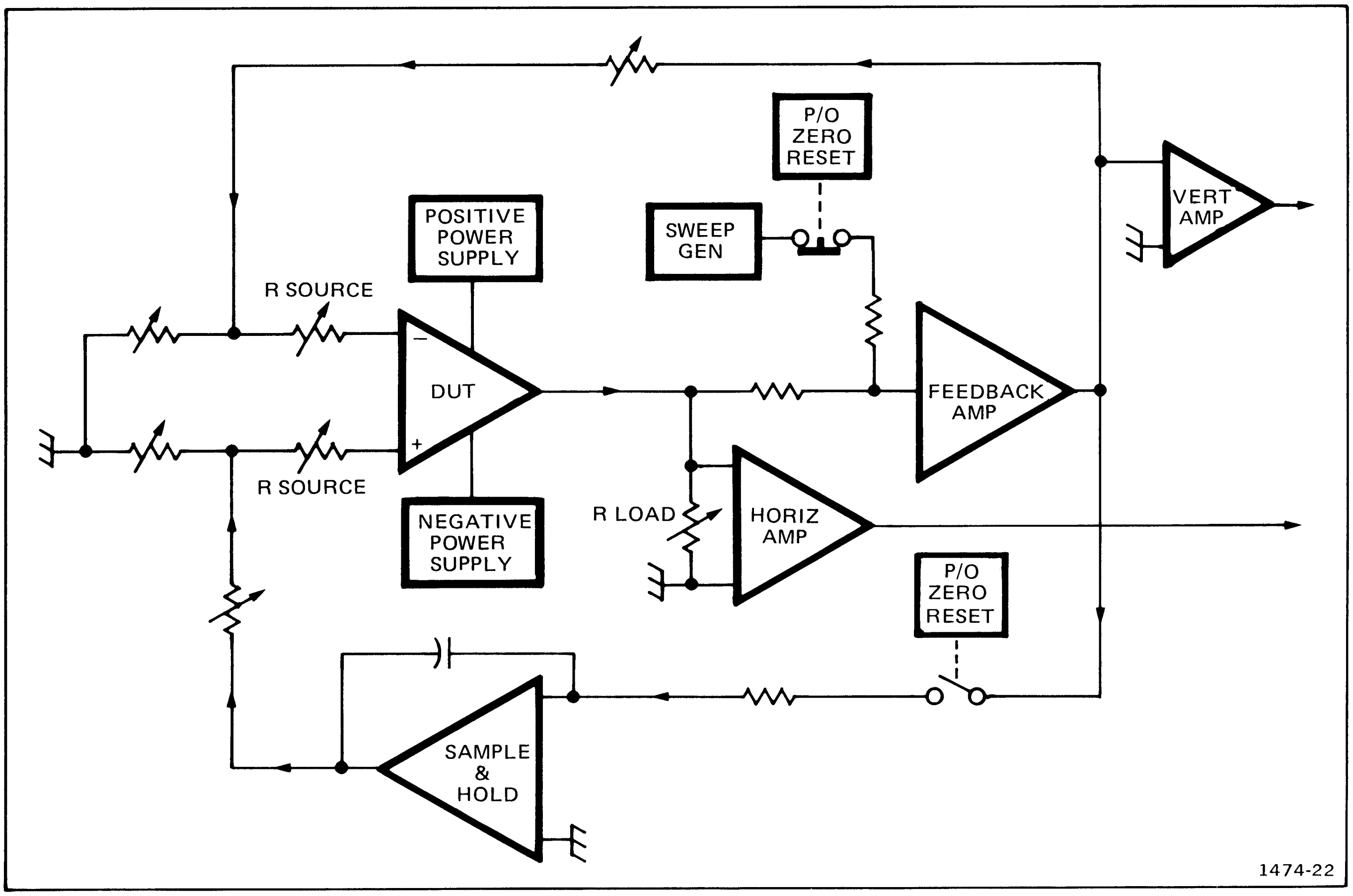

P/O
ZERO
RESET
POSITIVE
POWER
SUPPLY
SWEEP
GEN
VERT
AMP
R SOURCE
−
DUT
+
FEEDBACK
AMP
R SOURCE
NEGATIVE
POWER
SUPPLY
R LOAD
HORIZ
AMP
P/O
ZERO
RESET
SAMPLE
&
HOLD
1474-22

Fig. 3-5. Block diagram of GAIN configuration.

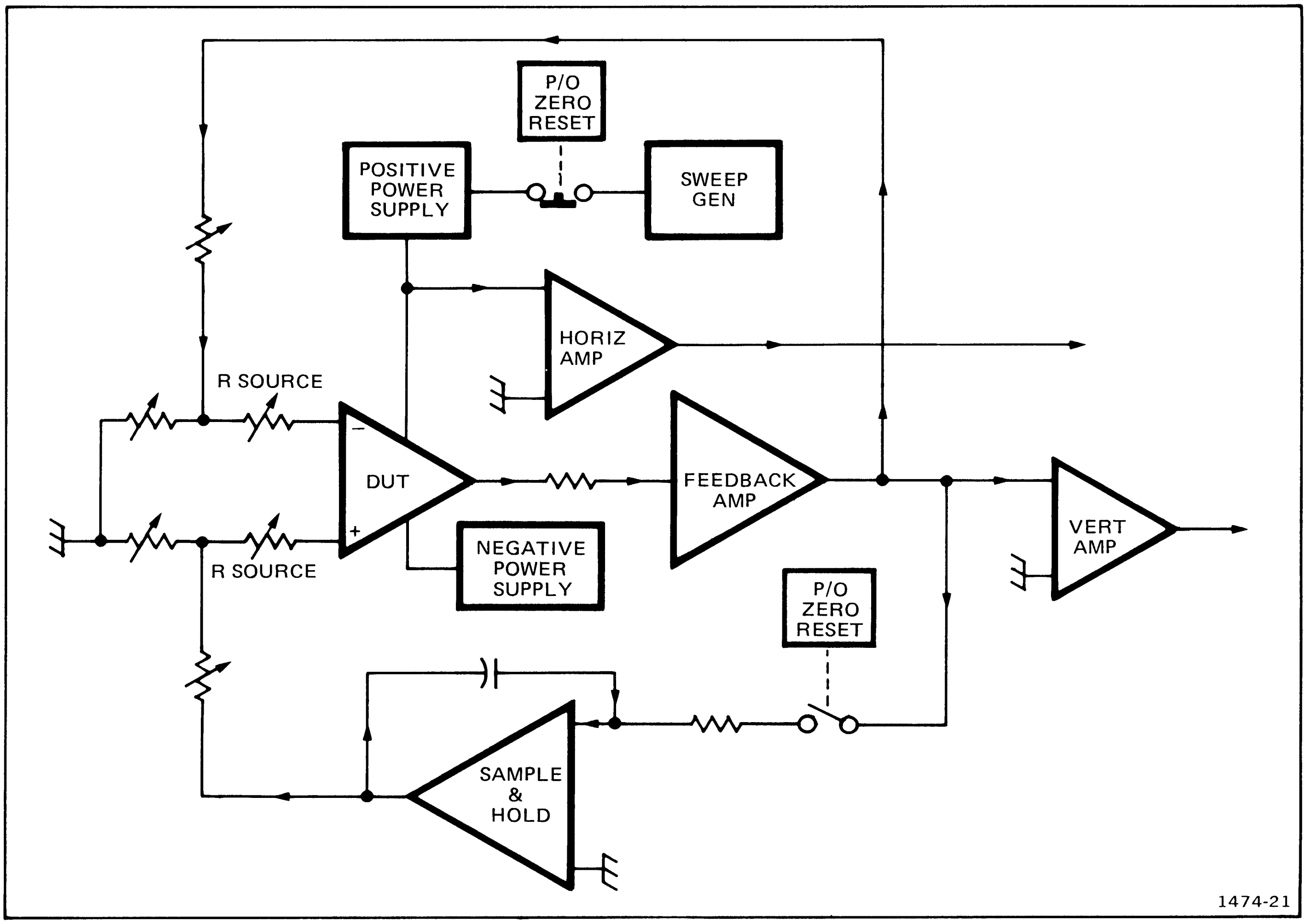

P/O
ZERO
RESET
POSITIVE
POWER
SUPPLY
SWEEP
GEN
HORIZ
AMP
R SOURCE
−
DUT
+
FEEDBACK
AMP
VERT
AMP
R SOURCE
NEGATIVE
POWER
SUPPLY
P/O
ZERO
RESET
SAMPLE
&
HOLD
1474-21

Fig. 3-6. Block diagram of + PSRR configuration.

+ PSRR

Refer to Fig. 3-6. The objective of the + PSRR test is to divide the change in power-supply voltage by the change in input voltage required to hold the output voltage constant. To do this, the Sweep Generator is connected to sweep the positive power supply; the horizontal axis displays this signal. The resultant change is sent to the Vertical Amplifier for display on the vertical axis.

− PSRR

Refer to Fig. 3-7. This test is identical to the + PSRR test, except that the minus supply is swept rather than the plus supply.

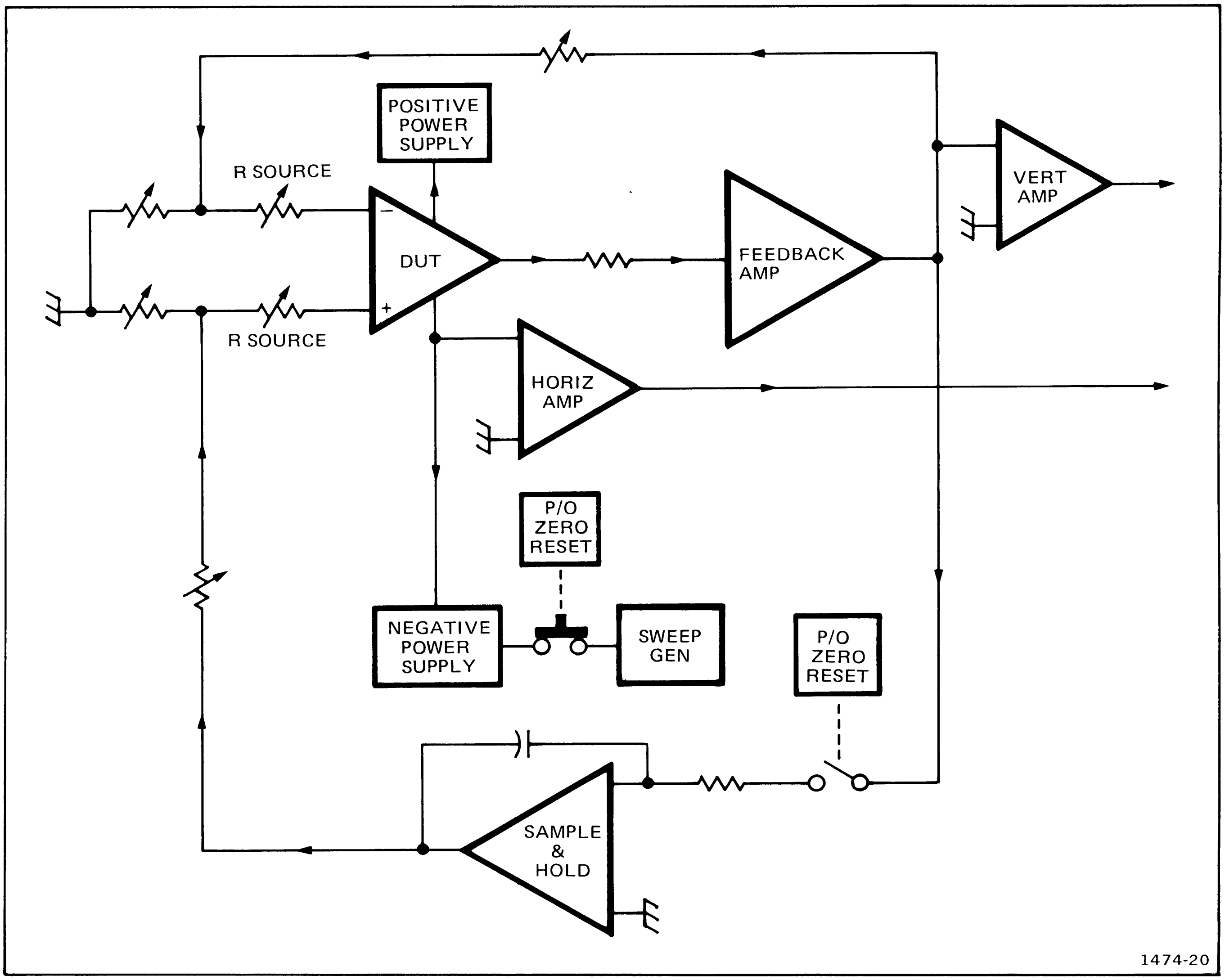

POSITIVE POWER SUPPLY
R SOURCE
R SOURCE
DUT
−
+
FEEDBACK AMP
VERT AMP
HORIZ AMP
P/O ZERO RESET
NEGATIVE POWER SUPPLY
SWEEP GEN
P/O ZERO RESET
SAMPLE & HOLD
1474-20

Fig. 3-7. Block Diagram of − PSRR configuration.

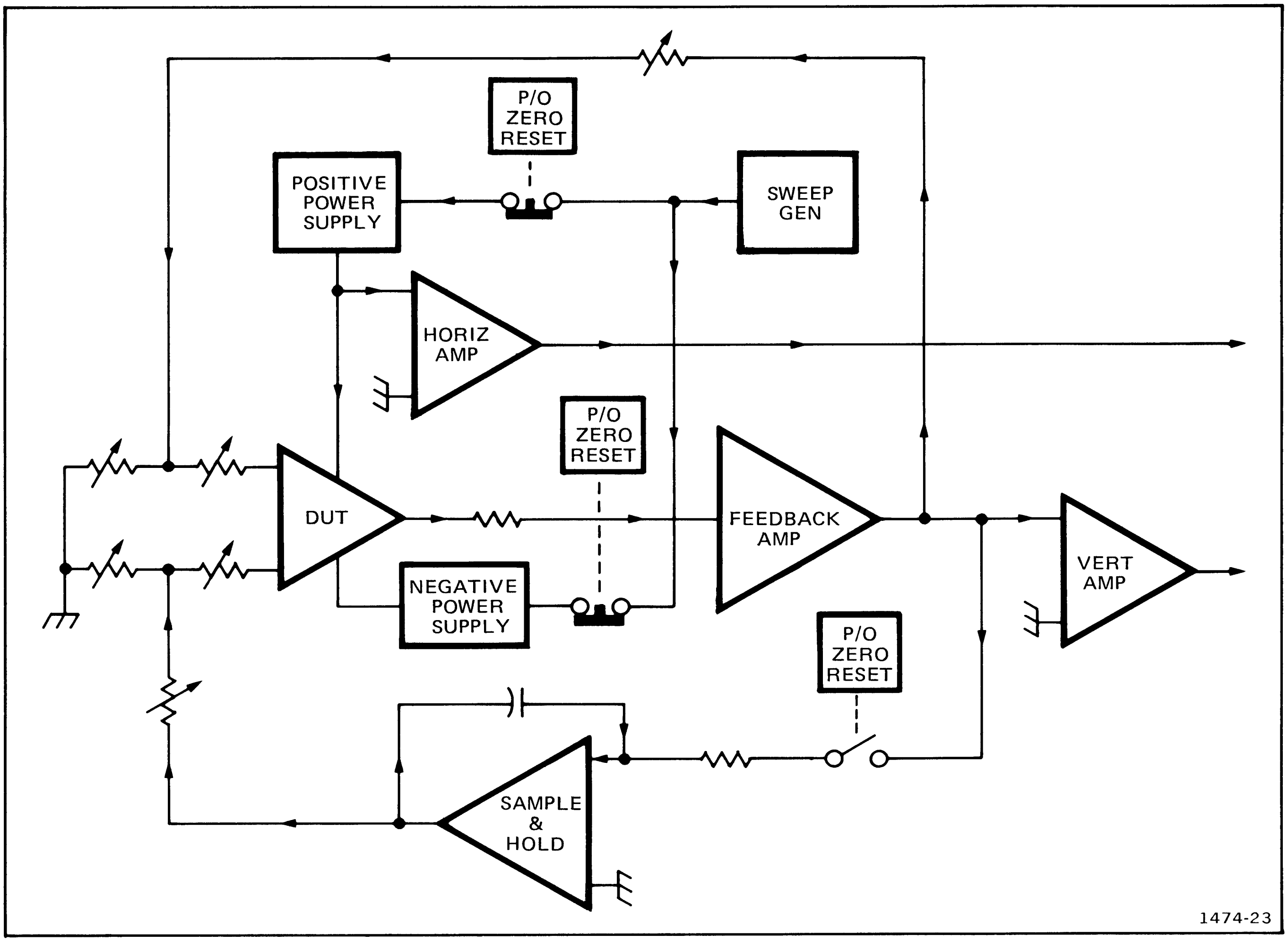

P/O
ZERO
RESET
POSITIVE
POWER
SUPPLY
SWEEP
GEN
HORIZ
AMP
P/O
ZERO
RESET
DUT
FEEDBACK
AMP
NEGATIVE
POWER
SUPPLY
VERT
AMP
P/O
ZERO
RESET
SAMPLE
&
HOLD
1474-23

Fig. 3-8. Block diagram of ± PSRR configuration.

± PSRR

Refer to Fig. 3-8. The ± PSRR configuration is similar to the previous two tests, except that the Sweep Generator output is applied to both the plus and minus supplies, and they are swept in opposite directions. The output of the positive supply is displayed on the horizontal axis, and the differential input voltage to the DUT is displayed on the vertical axis.

+ SUPPLY I

Refer to Fig. 3-9. The power supply voltage is swept by the output of the Sweep Generator in this configuration. The output of the positive power supply is fed through the I/V Converter, then the Vertical Amplifier for display of the power supply current. The Horizontal Axis displays the swept power supply voltage.

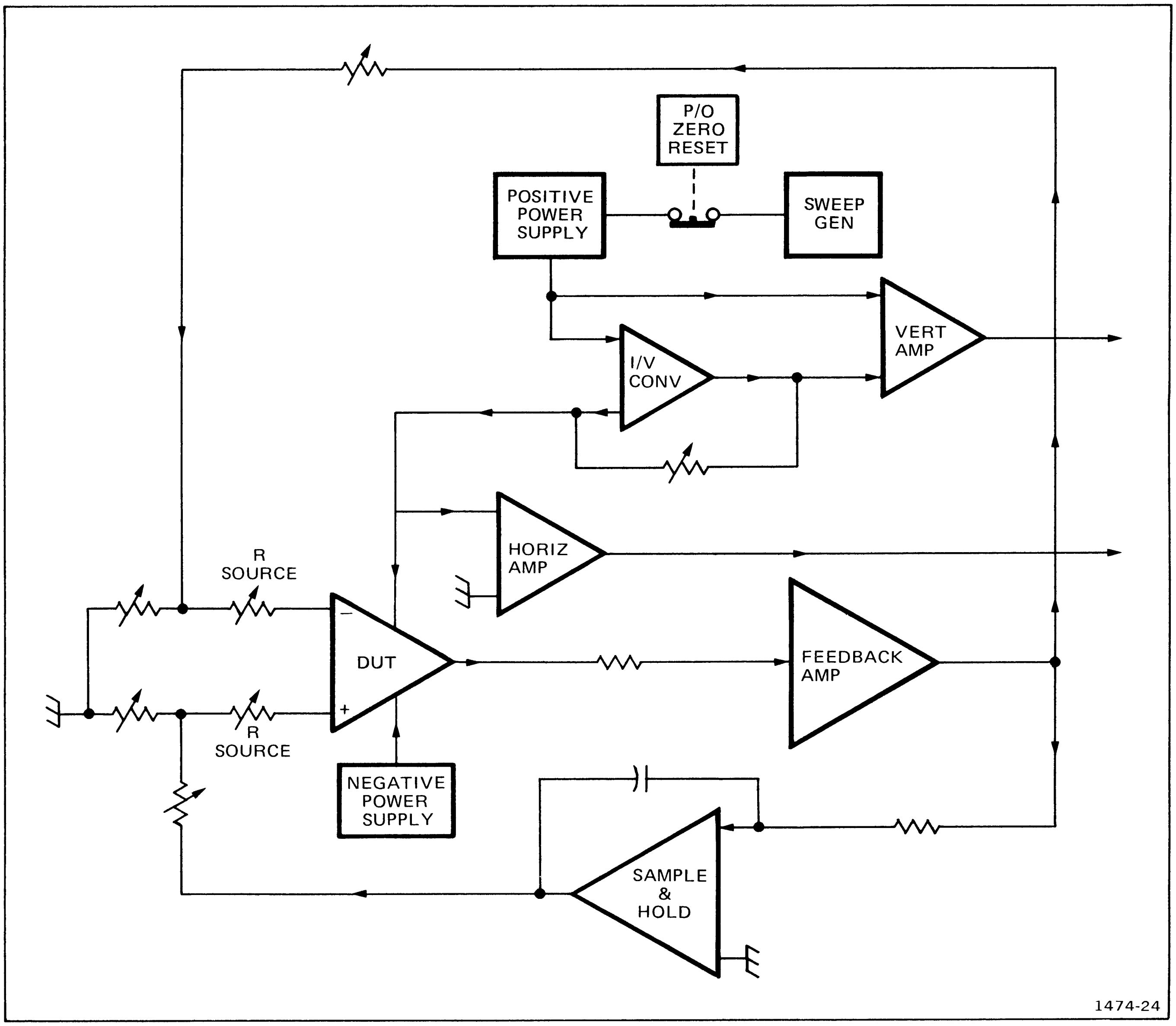

P/O
ZERO
RESET
POSITIVE
POWER
SUPPLY
SWEEP
GEN
VERT
AMP
I/V
CONV
HORIZ
AMP
R
SOURCE
DUT
−
+
R
SOURCE
FEEDBACK
AMP
NEGATIVE
POWER
SUPPLY
SAMPLE
&
HOLD
1474-24

Fig. 3-9. Block diagram of + SUPPLY I configuration.

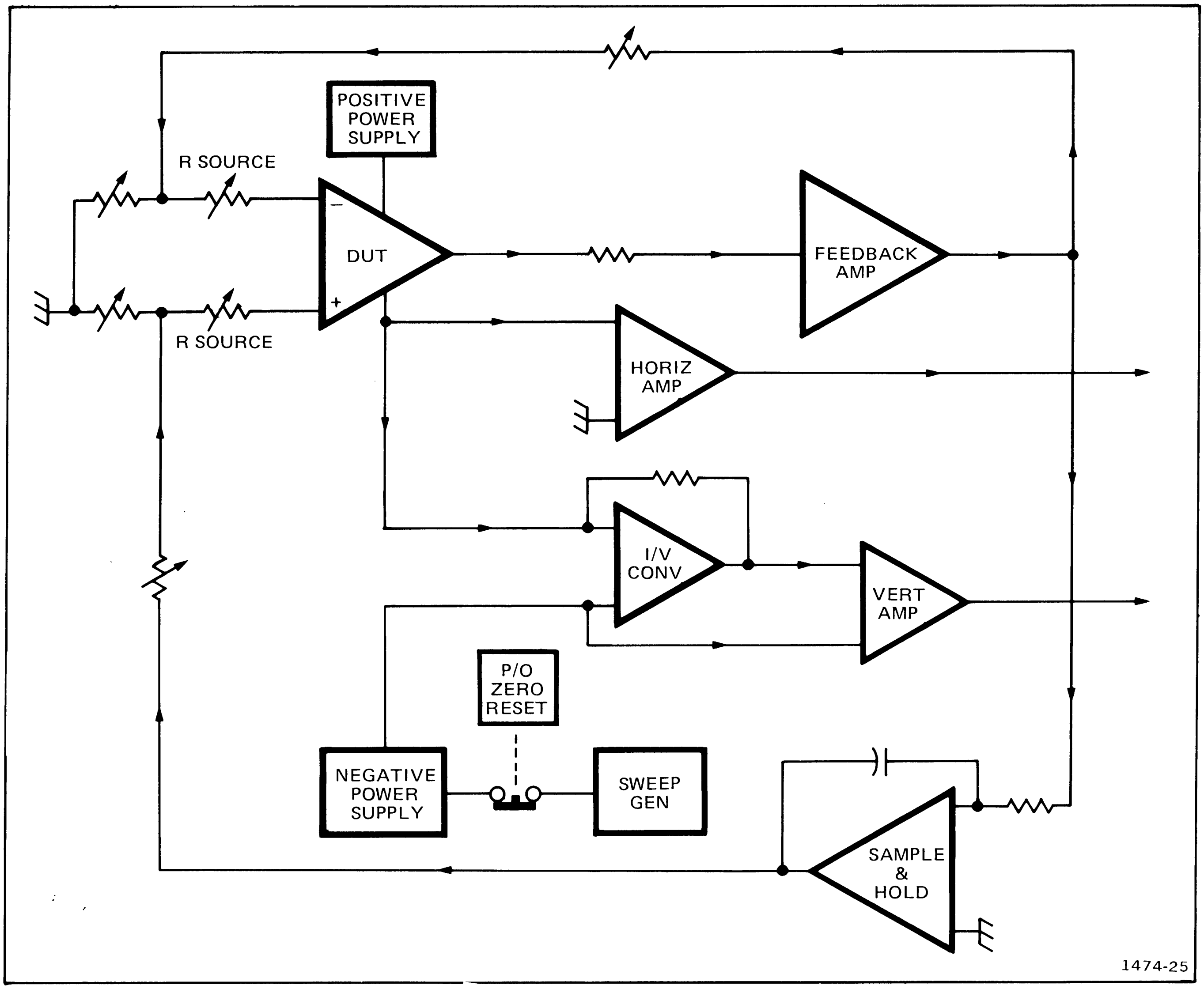

POSITIVE POWER SUPPLY
R SOURCE
R SOURCE
DUT
−
+
FEEDBACK AMP
HORIZ AMP
I/V CONV
VERT AMP
P/O ZERO RESET
NEGATIVE POWER SUPPLY
SWEEP GEN
SAMPLE & HOLD
1474-25

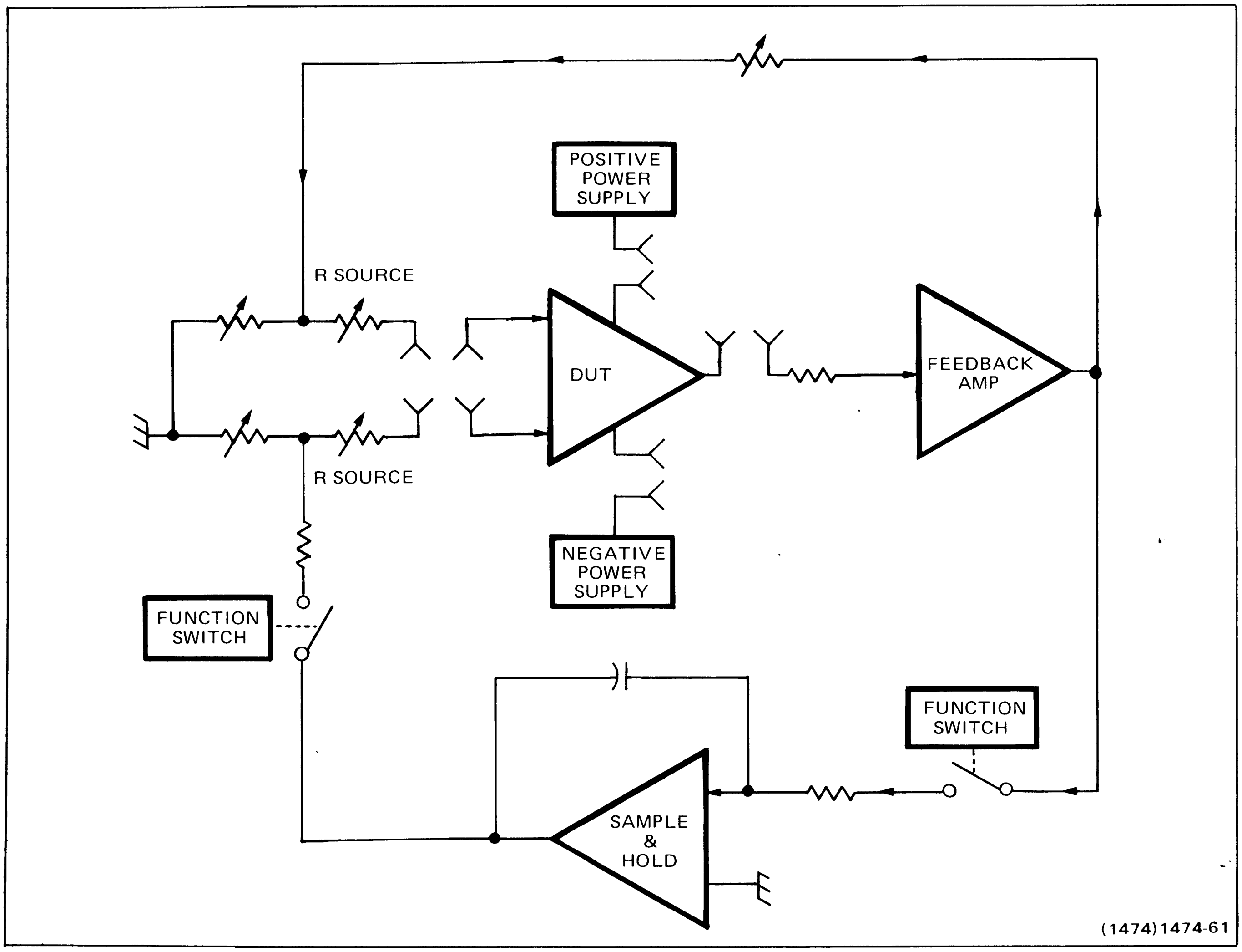
Fig. 3-10. Block diagram of − SUPPLY I configuration.

− SUPPLY I

Refer to Fig. 3-10. This configuration is identical to the + SUPPLY I configuration, except that the minus power supply voltage is swept and both current and voltage are displayed.

COLLECTOR I

Refer to Fig. 3-11. This is the "standard" curve-tracer configuration. The collector supply is connected to the Horizontal Amplifier, and by way of the I/V Converter, to the Vertical Amplifier. The configuration not only permits the operator to use the 178 and 577 as a standard curve tracer, but also permits using the collector supply to replace either of the DUT power supplied (+ or −). The collector supply can also be patched to any other points on the DUT card as required by a particular test where current vs voltage measurements of the collector supply are required.


POSITIVE POWER SUPPLY
R SOURCE
DUT
FEEDBACK AMP
R SOURCE
NEGATIVE POWER SUPPLY
FUNCTION SWITCH
FUNCTION SWITCH
SAMPLE & HOLD
(1474)1474-61

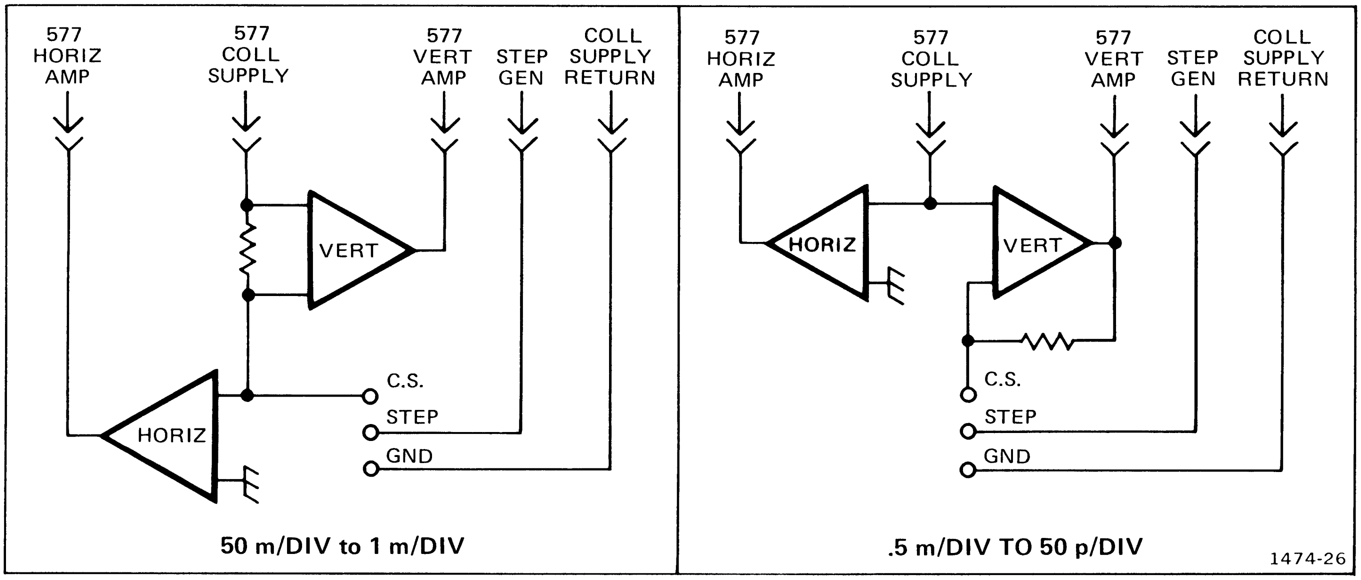

577 HORIZ AMP
577 COLL SUPPLY
577 VERT AMP
STEP GEN
COLL SUPPLY RETURN
VERT
HORIZ
C.S.
STEP
GND
50 m/DIV to 1 m/DIV
577 HORIZ AMP
577 COLL SUPPLY
577 VERT AMP
STEP GEN
COLL SUPPLY RETURN
HORIZ
VERT
C.S.
STEP
GND
.5 m/DIV TO 50 p/DIV
1474-26

Fig. 3-11. (A) Block diagram of COLLECTOR SUPPLY I configuration; (B) Horizontal and vertical connection for COLLECTOR SUPPLY I configuration.

DETAILED CIRCUIT DESCRIPTION

Vertical Preamplifier

Refer to Diagram 1. The vertical preamplifier consists of three major circuits, the preamplifier circuit, the I/V Converter, and the Looping Compensation Amplifier.

Preamplifier. This circuit consists of two operational amplifiers, U340B and U350A, plus related components. The first, U340B, has a nominal gain of 1, 10, or 100, depending on which of the three feedback resistors is selected. R331 is the input resistance of the amplifier. The plus input of U340B is controlled by the level adjusted by R340, VERT PREAMP BAL, which is adjusted for the least vertical display shift between vertical sensitivity settings. The second amplifier, U350A, has a nominal gain of 1, 2.5, or 5, depending on the setting of the vertical sensitivity switch. R351 is the input resistor. Display Zero switch S200A is used to connect the minus input to the floating power supply common (to which the plus input of each amplifier is returned) in order to establish a reference point on the display. The preamp receives signals from the feedback amplifier or the I/V Converter; the first is used in the display of voltage on the vertical axis, and the second is used for current displays on the vertical axis.

I/V Converter. The current-to-voltage converter (I/V Converter) consists of operational amplifier U340A and dual FET Q310, plus surrounding components. Feedback resistors R321, R322, and R323 are switched in parallel with R324 to select the gain of the amplifier for various vertical units/div settings.

In all but the six highest current settings of the vertical units/div switch, the I/V Converter operates in the "virtual ground" method. This is a case in which there is effectively no input resistance to the amplifier.

When the vertical units/div switch is set to one of the six highest settings, the converter operates in a more conventional voltage amplifier mode. Resistor R305 is switched into the minus input to operate as the input resistance to the amplifier, and R301 and R302 are placed across the plus and minus inputs; the input current is applied to and voltage is developed across the two resistors. Converter Bal adjustment R310 is adjusted to match the output of the converter to the input of the Vertical Preamp.

The I/V Converter is switched in or out of the input path of the vertical preamp by the function switch; it is in the path when the INPUT I, SUPPLY I, and COLLECTOR SUPPLY I functions are selected. Otherwise, the output of the feedback amplifier is connected directly to the input of the vertical preamplifier.

Looping Compensation. Amplifier U350B compares chassis ground, through an extremely high resistance (R316-R317), with the floating power supply common. Looping adjustment R315 is connected across the amplifier to act as the feedback resistor for the amplifier. The resistor, and thus the gain of the amplifier, is adjusted to reduce looping of the display that occurs during high-sensitivity current measurements.

Feedback Amplifier Circuits

Refer to Diagram 2. This diagram depicts the Feedback Amplifier, the Sample & Hold circuit, and the indicator drive circuits. The Feedback Amplifier and related components form the network that amplifies the DUT output and feeds it back to cancel the original driving signal at the minus input of the DUT. The Sample and Hold amplifier performs essentially the same function at the plus input of the DUT, to compensate for the differential offset voltage between inputs.

Feedback Amplifier. Transistors Q214, Q222, and Q226 form a non-inverting operational amplifier. Inputs to the amplifier are fed through equal-value summing resistors to reduce dc input shift. The gain of the stage is approximately three, as set by R223 and R227. Feedback Bal adjustment R229 is set for zero dc level change from input to output of the stage.

Resistors R231, R233, R235, and R238 form the feedback string that passes the output signal to the DUT minus input. Vertical units/div switch contacts include or exclude resistors in the string to allow for different sensitivities.

The reader should note that the output of the Feedback Amplifier, through P235 pins 1 and 2, is illustrated far less complex than it actually appears in the circuit. The output signal from Q226 passes through P235 pin 3, through the Interface connector (see Diagram 6), through pin B22 of the Standard Op Amp Card (see Diagram 7) through switch S30. This switch permits the use of an externally connected feedback amplifier in line with the internal circuitry of the 178. From the switch, the signal passes through pin B23, back through the interface connector, through pin 1 of P235 and to the divider string shown on Diagram 2. As noted above, the circuit is drawn as shown for clarity of illustration, since the normal mode of operation is without the external feedback amplifier.

Sample and Hold Amplifier. Dual FET Q252 and amplifier U250 form the Sample and Hold Amplifier. The amplifier is used to force the plus input of the DUT to whatever level that will allow the minus input to reach zero volts.

The X1000 CMRR, X100 CMRR, and X10 CMRR adjustments (R262, R265, and R267, respectively) are used to compensate for slight variations in the values of the resistors used in the output divider string. The vertical units/div switch selects combinations of resistance in the output divider string to allow for different sensitivity selections.

Indicator Drive Circuits. Transistors Q284 and Q286 energize the front-panel volts and amps indicators, respectively. The two conduct exclusively; that is, when Q284 is conducting, it prevents Q286 from conducting. Likewise, when Q284 is cut off, base current for Q286 is furnished through the VOLTS lamp, and the transistor conducts. Emitter current is furnished for both transistors through Q280.

Control for the drive circuits comes from the FUNCTION switch (F6), the VERTICAL UNITS/DIV switch (V1), and the Vertical Mag switch in the 577. When the Function switch is set to any of the current measurement positions, contact F6 is open, cutting Q284 off, and permitting Q286 to conduct. If the Vertical Units/Div switch is set to 5 μA or less, contact V1 is closed, which cuts off Q280. This in turn cuts off both transistors, since no voltage measurements are made below 10 μV.

Power Supply Circuits

See Diagram 3. The Power Supply consists of the Sweep Generator, Sweep Amplifier, Plus and Minus Supply Regulators, Current Limit circuits, and the Current Overload Indicator circuits. The circuits depicted furnish plus and minus dc and swept voltages to the supply terminals of the DUT, and a sine-wave signal to sweep the Feedback Amplifier.

Sine-Wave Generator. This circuit consists of a square-wave generator, an integrator-shaper circuit, and an amplifier. The Generator first generates a square wave, integrates it to form a triangle wave, then shapes the triangle wave into a sine wave. The sine wave is then amplified and sent to the Sweep Amplifier circuits.

Comparator Q402-Q404, along with Q408 and Q406, form the square-wave generator. Sweep frequency is controlled by the position of S420, which selects different resistance values for each frequency range. Variable frequency control is accomplished by R415. The calibration of the front-panel frequency controls is performed by adjusting R410.

The signal from the emitter of Q408, which swings from about +29 volts to about −29 volts, is coupled through the frequency-selected network to the input of U424. This amplifier, in conjunction with C424 and C425, integrates the square wave into a triangle waveshape. The outputs of U424 and Q408 are summed through R402 and R401 and applied to the comparator input. This causes the comparator to switch when the output of U424 is at about 5 volts. The triangle wave is fed through R426 to the shaper network.

The shaper network consists of two main sections: Q442, CR443, CR444, and CR445 act upon the negative half of the input triangle wave; Q452, CR453, CR454, and CR455 shape the positive half of the triangle wave. Since the two sections act upon the input signal in the same way, only the upper (Q442) half will be discussed.

Voltage divider R441-R442 holds the base of Q442 at about −3.2 volts. Q442 is conducting, so its emitter rests at about −2.5 volts. All three diodes are back-biased with no signal applied, so the anode of CR443 is at about −2.5 volts, CR444 is at about −2 volts, and CR445 is at about −1.1 volts. Thus, as the triangle wave is applied to the shaper circuit, the level at the cathode of CR445 drops until the diode begins to conduct, changing the effective load at the output of the integrator. As the applied signal continues to drop, CR444, then CR443 conduct, further changing the load on the integrator. The resultant output seen at TP448 is a sinusoidal waveshape that is applied to the amplifier.

Amplifier U432A is used to isolate the shaping circuit from the impedance changes that occur when the SWEEP AMPLITUDE control is changed. The stage has a gain of approximately one, as determined by the ratio of R432 to R449. During power supply rejection ratio and supply current tests, −30 volts is connected through R431 to the input of U432A. Through divider action, this offsets the output of the amplifier by about three volts. This action is used in tests in which the sweep signal must vary in only one direction from zero.

Manual Sweep. Normally, in automatic sweep operation, SWEEP AMPLITUDE control R460 is connected across ground and the output of U432A. When MANUAL SWEEP is selected, R460 is connected across the output of U460A and U460B. The voltage applied to the input of U460A varies from zero to about −6 volts, depending on the setting of R560, the + SUPPLY control. R562, the Supply Cal adjustment, is set for 60 volts (with R560, + SUPPLY control, set to 30 V) across the front-panel SUPPLY jacks; this places +5 volts at the output of U432B.

In the three PSRR and two SUPPLY I positions of the FUNCTION switch, contact F4 is closed, connecting −30 volts to R461 and saturating Q462. The collector of Q462 is at ground, holding the input and output of voltage follower U460B at ground. In manual sweep, then, the bottom of R460 is held at ground for the above-mentioned functions.

U432B is also a voltage follower, so the voltage tapped off R560 is also that appearing at the output of U432B. This potential, about −5 volts, is applied through R467 to the input of U460A, which has a gain of about 0.6. The voltage at the output of U460A (about +3 volts) is applied to the top end of R460; thus, in the PSRR and SUPPLY I positions of the FUNCTION switch, about three volts maximum is applied across R460 when manual sweep operation is selected.

When the 178 is operated in the functions other than the PSRR and SUPPLY I tests, switch contact F4 is open, and Q462 is cut off. The voltage from the output of U432A is divided across R463 and R464, applying about 60% to the input of U460B. The output level of U460B, about −3 volts, is applied to the bottom end of R460. (The +3 volts from U460A is still applied to the top of R460.) Thus, for functions other than PSRR and SUPPLY I, approximately twice the voltage is applied across R469.

Sweep Amplifier. The Sweep Amplifier consists of Field Effect Transistor Q520, Integrated operational amplifier U540, and four bipolar transistors, Q536, Q538, Q546, and Q548. The amplifier is fundamentally an inverting operational amplifier having a gain of ten; the ratio of R527 and R549 set the gain of the stage. Q520, by means of the F1 contact of the FUNCTION switch (closes between positions of the switch) or contact B of the DISPLAY ZERO switch, disconnects the input signal from the Sweep Amplifier. The output of the stage is applied to the + Supply through contact F8, the − Supply through contact F3, and to the DUT via J201-2 (Diagram 2). The sweep amplifier output is connected to the DUT power supplies to sweep the supplies in PSRR and SUPPLY I modes, and forces the DUT inputs in CMRR and INPUT I modes. The FUNCTION switch is used to select the desired mode.

Supplies and Regulators. The sweep amplifier sine-wave output signal is applied to the + DUT supply via switch contact F8, divided through R570-R571, and applied to U576, which sets both the output voltage of Q584 and the + DUT voltage out.

The sine-wave output from the Sweep Amplifier is also applied to the − DUT supply, through divider R551-R552, contact F3, then to the input of U476, which sets both the output voltage of Q484 and the − DUT voltage out.

The + SUPPLY dc level is set by U432B and R560. This dc level is applied to pin 2 of U576. The result of the dc level on pin 2 of U576 and a sine wave on pin 3 is a dc level at the output, pin 6, swept at the sine-wave rate.

The − SUPPLY dc level is set by R565 (through switch S565) when it is out of the detent (fully counterclockwise) position in the same manner as the + SUPPLY dc level is set. The − SUPPLY can be swept by the sweep generator at the sine-wave rate.

When the − SUPPLY control is in the detent position (TRACK + SUPPLY), both supplies have the same absolute value of voltage out and are under control of precision + SUPPLY control R560.

The Output amplifiers, U476 and U576, can furnish no more than about 20 mA to the load; thus, Q484 and Q584 are used as series-pass transistors to drive the DUT inputs.

Current Limiting and Overload Indication. The resistors on the DUT card that are marked + I LIMIT and − I LIMIT control the voltage across the base-emitter junction of the current limiter transistors, Q572 and Q472, respectively. Since the circuits are identical, only the plus supply is discussed here.

The + I LIMIT potentiometer is adjusted by the operator to limit the current to be furnished by the supply. The combination of R586, R584, and the + I LIMIT resistor can vary the current limit point from about 1 mA to about 150 mA. Assume that the + I LIMIT resistor is set to limit at 50 mA. Its resistance, plus that of R586, is set at about six ohms. If the collector current of Q584 exceeds 50 mA, the base of Q572 is pulled negative sufficiently to cause it to conduct. Q578 is immediately biased on, lighting the (+) OVERLOAD indicator lamp. Also, the minus input of U576 is pulled positive, which in turn causes its output to move negative. This change is coupled to the base of Q584, reducing its conduction and limiting the current supplied to the DUT.

MAINTENANCE

Introduction

This section of the manual contains information for use in preventive and corrective maintenance, with some aids to troubleshooting.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection, lubrication, etc. Preventive maintenance performed on a regular basis improves instrument reliability. The severity of the environment in which the instrument is used determines the frequency of maintenance.

Cleaning

The 178 Test Fixture should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause leakage current and component breakdown, especially in a humid atmosphere.

Exterior. Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or a small paint brush. The paint brush is particularly useful for dislodging loose dust on and around the front-panel controls. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should be avoided.

Interior. Dust in the interior of the instrument should be removed occasionally to prevent electrical conduction in high-humidity environments. Using dry, low-velocity air, blow out accumulated dust. Remove any remaining dirt with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning circuit boards.

CAUTION

Avoid the use of chemical cleaning agents that might damage the plastics used in the instrument. Do not use chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.

Lubrication

The reliability of potentiometers, rotary switches, and other moving parts can be maintained if they are kept properly lubricated. Use a cleaning-type lubricant on rotary switch contacts. Lubricate switch detents with heavier grease (such as Tektronix Part No. 006-0219-00). Do not lubricate cam switches.

NOTE

Shaft bushings of potentiometers that are not sealed should be lubricated with a lubricant that will not affect the electrical characteristics. Do not over-lubricate. A lubrication kit (Tektronix Part No. 003-0342-01) is available.

Visual Inspection

The 178 Test Fixture should be inspected occasionally for such defects as broken connections, loose pin connections, improperly seated transistors, damaged circuit boards and heat damaged parts.

The corrective procedure for most visible defects is obvious. However, particular care must be taken if heat damaged components are found. Overheating usually indicates other trouble in the instrument. It is, therefore, important that the cause of overheating be corrected to prevent recurrence of the damage.

Transistors and Integrated Circuits

Periodic checks of individual transistors and integrated circuits are not recommended. The best check is their operation in the equipment as reflected by performance. Sub-standard performance is normally detected during a performance check or calibration procedure.

Recalibration

To ensure accurate measurements, check the instrument calibration after each 1000 hours (approximately) of operation, or if the instrument is used infrequently, every year. Replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in the Performance Check/Adjustment section. The Performance Check/Adjustment procedure can also be helpful in locating troubles.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting the 178. Information contained in other sections of this manual should be used with the following information to aid in locating circuit defects (see Operating and Circuit Description sections).

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 178.

1. **Semiconductor Tester.** Some means of testing the transistors, diodes, FETs, and linear op amps used in the instrument is helpful. A curve tracer, such as the Tektronix 575, 576, or 577-177 (577-178 for linear op amps) gives the most complete information.

2. **DC Voltmeter and Ohmmeter.** A voltmeter for checking circuit voltages and an ohmmeter for checking resistances and diodes are required. For most applications, a 20,000 ohms/volt VOM can be used if allowances are made for circuit loading when measuring voltage at high impedance points.

3. **Test Oscilloscope.** An oscilloscope with a DC to 1 MHz bandwidth and 10 mV/Div to 10 V/Div vertical deflection factor is suggested. A 10X probe should be used to reduce circuit loading.

Troubleshooting Aids

Diagrams. Circuit diagrams are located on foldout pages in the Diagrams section near the rear of the manual. The component number and electrical value of each component is shown. See the first page of the Diagrams section for definition of the symbols used to identify components.

An overall block diagram (SWITCH CONFIG BLOCK DIAGRAM) is provided in the DIAGRAMS section. This block relates the circuits to the FUNCTION and VERTical UNITS/DIV switch contact numbers.

Circuit Description. The Circuit Description, Section 3, contains a brief description of the theory of circuit operation. The circuit configuration for each function switch position is shown in the series of block diagrams, Figures 3-1 through 3-11. Also, refer to the schematic diagrams in the pullout diagrams section.

Transistors and Integrated Circuit Lead Configurations. The lead configurations of the transistors and ICs in the 178 Test Fixture are shown on the schematic diagram introduction page.

Voltages and Waveforms. Important voltages and waveform are shown on the diagrams.

Capacitor Values. Values of disc capacitors are marked on the capacitor body and electrolytic capacitor values are marked either on the capacitor body or are color coded (see Fig. 4-1).

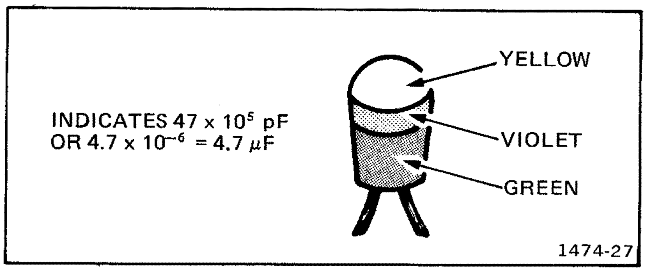

INDICATES 47×10^5 pF
OR $4.7 \times 10^{-6} = 4.7\ \mu$F
YELLOW
VIOLET
GREEN
1474-27

Fig. 4-1. Electrolytic capacitor color code.

Diode Color Code. The cathode end of each glass enclosed diode is indicated by a stripe, a series of stripes, or a dot. For diodes using a series of stripes, the color code identifies either the Tektronix part number of the JEDEC number. This code follows the standard color code except that a pink first band indicates a Tektronix part number, i.e., pink-brown-grey-green, indicates Tektronix Part No. 152-0185-00.

Circuit Boards. A depiction of each circuit board that relates to the circuit diagram with circuit components identified, is included on the back of the preceding circuit diagram. Each circuit board photo is sectioned by a grid system to facilitate rapid location of components by component number.

Access to Circuit Boards in the 178

1. Remove the side panels.

   a. Remove the six screws on each side (note the two screw types: self-threading and machine).

2. Remove the bottom panel.

   a. Remove the three pan-head machine screws from the bottom panel (see Fig. 4-2).

   b. Remove the four flat-head machine screws from the bottom panel.

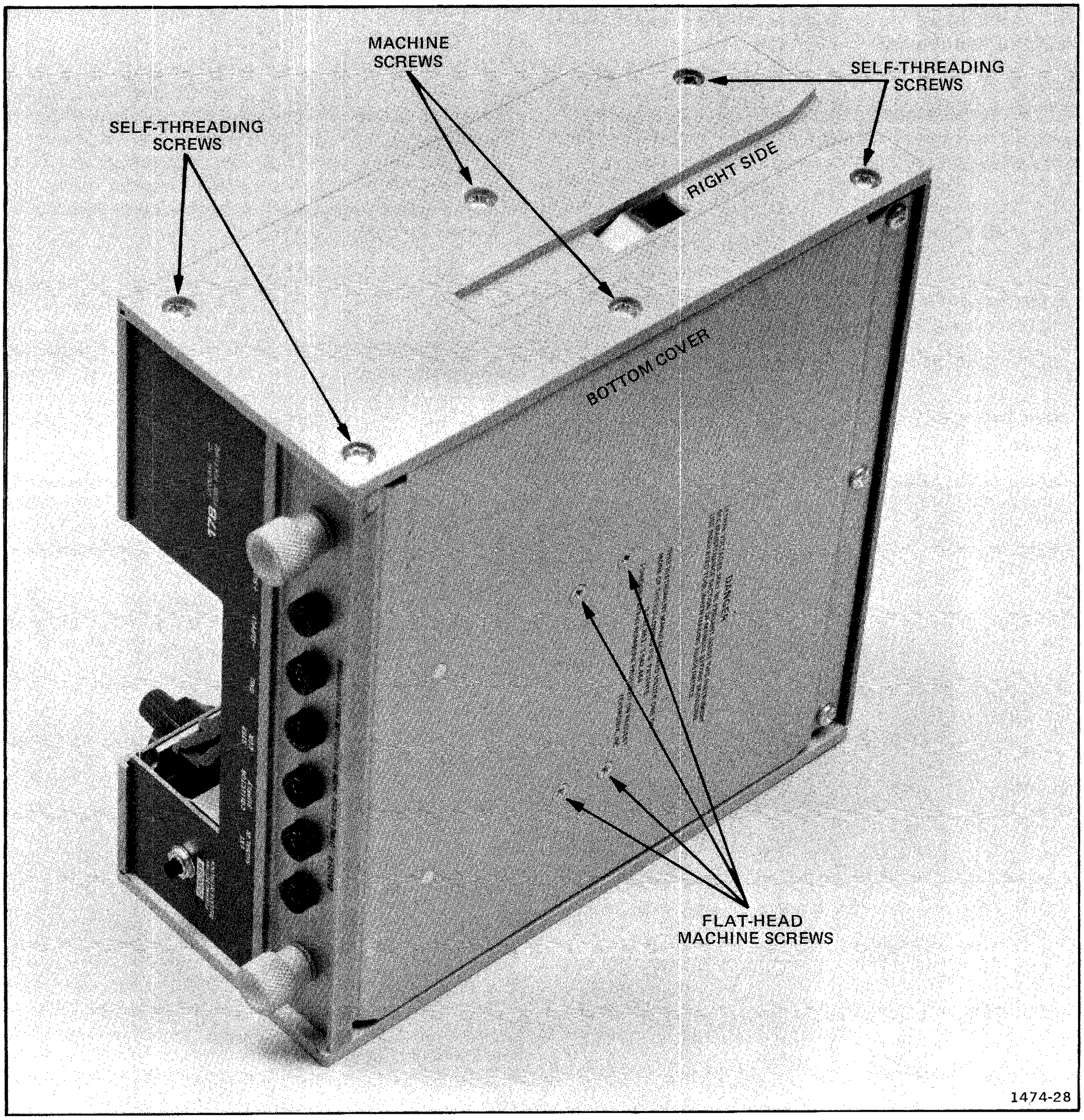

MACHINE SCREWS
SELF-THREADING SCREWS
SELF-THREADING SCREWS
RIGHT SIDE
BOTTOM COVER
FLAT-HEAD MACHINE SCREWS
1474-28

Fig. 4-2. Right-side and bottom panel of the 178.

c. Remove the two pan-head machine screws from inside the storage compartment (see Fig. 4-3).

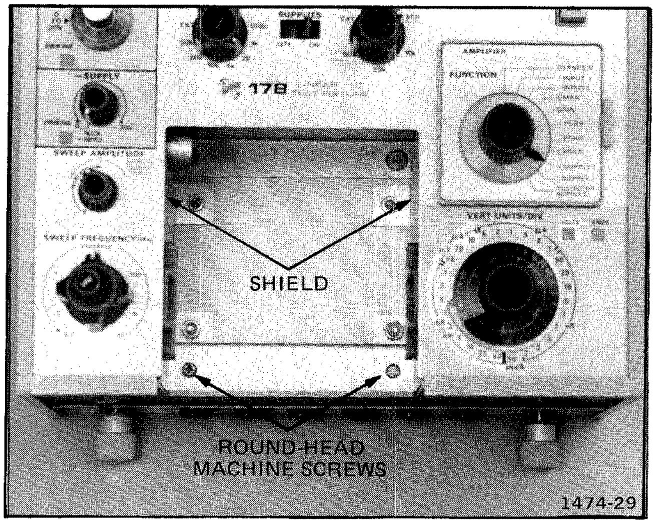
d. Remove the two shields that form the side of the storage compartment. See Fig. 4-3. (The front shield held in place with two hex nuts, Fig. 4-3, need not be removed).

e. Remove the bottom panel.

Removing the Vertical Preamplifier and Feedback Amplifier Boards from the 178

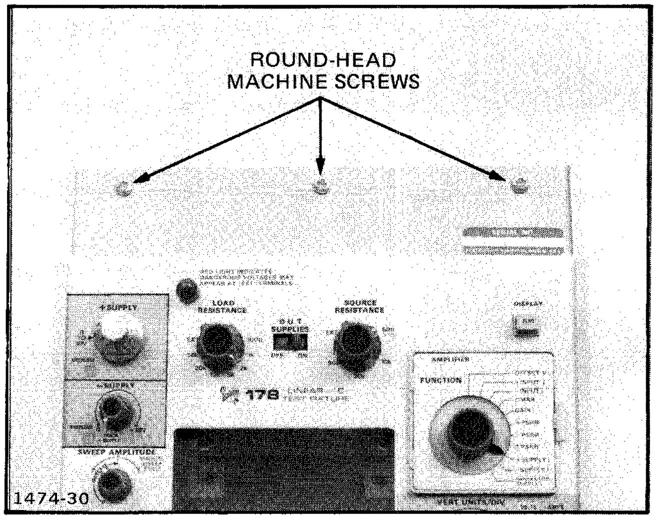
1. Remove the Power Supply circuit board as follows:

a. Remove the eleven multi-pin connectors from the Power Supply circuit board. See Fig. 4-5 for circuit-board location.



178
SUPPLIES
AMPLIFIER
FUNCTION
-SUPPLY
SWEEP AMPLITUDE
SWEEP FREQUENCY
VERT UNITS/DIV
SHIELD
ROUND-HEAD
MACHINE SCREWS
1474-29

Fig. 4-3. Top view of the 178 showing storage-compartment shields.



ROUND-HEAD
MACHINE SCREWS
+SUPPLY
-SUPPLY
LOAD RESISTANCE
SOURCE RESISTANCE
D.U.T SUPPLIES
DISPLAY
AMPLIFIER
FUNCTION
178
SWEEP AMPLITUDE
VERT UNITS/DIV
1474-30

Fig. 4-4. Top view of the 178.

NOTE

The last digit in the number of the circuit-board to which the mulit-pin connector is mated indicates the color of the connector body. The standard color code is used. For example, the connector body color for P473 is orange. An arrow on the circuit board indicates pin number one on the board. Pin number one is marked with an arrow on the plug. Align the arrows for correct position.

b. Remove the red connector (P222) from the rear of the Feedback Amp board. Lift the pair of wires (attached to the red connector) away from the Power Supply circuit board.

c. Remove the three round-head machine screws from the top-rear of the instrument (Fig. 4-4).

d. Slide the Power Supply circuit board and rear-panel assembly away from the instrument far enough to unsolder the two black panel-lamp leads.

e. Remove the circuit board and rear-panel assembly.

2. Remove the Vertical Preamp, Feedback Amp, and Interface Boards (remove as a unit) as follows:

a. Remove the six multi-pin connectors (color coded as previously detailed).

b. Lift the three-lamp holder caps away from the platic sleeves (see Fig. 4-6).

c. Note the positions of the VERT UNITS/DIV and FUNCTION switches and remove the switch knobs.

d. Note the positions of the SOURCE RESISTANCE and LOAD RESISTANCE knobs and remove the knobs.

e. Remove the hex nut and washer from the SOURCE RESISTANCE, LOAD RESISTANCE, and FUNCTION switch shafts.

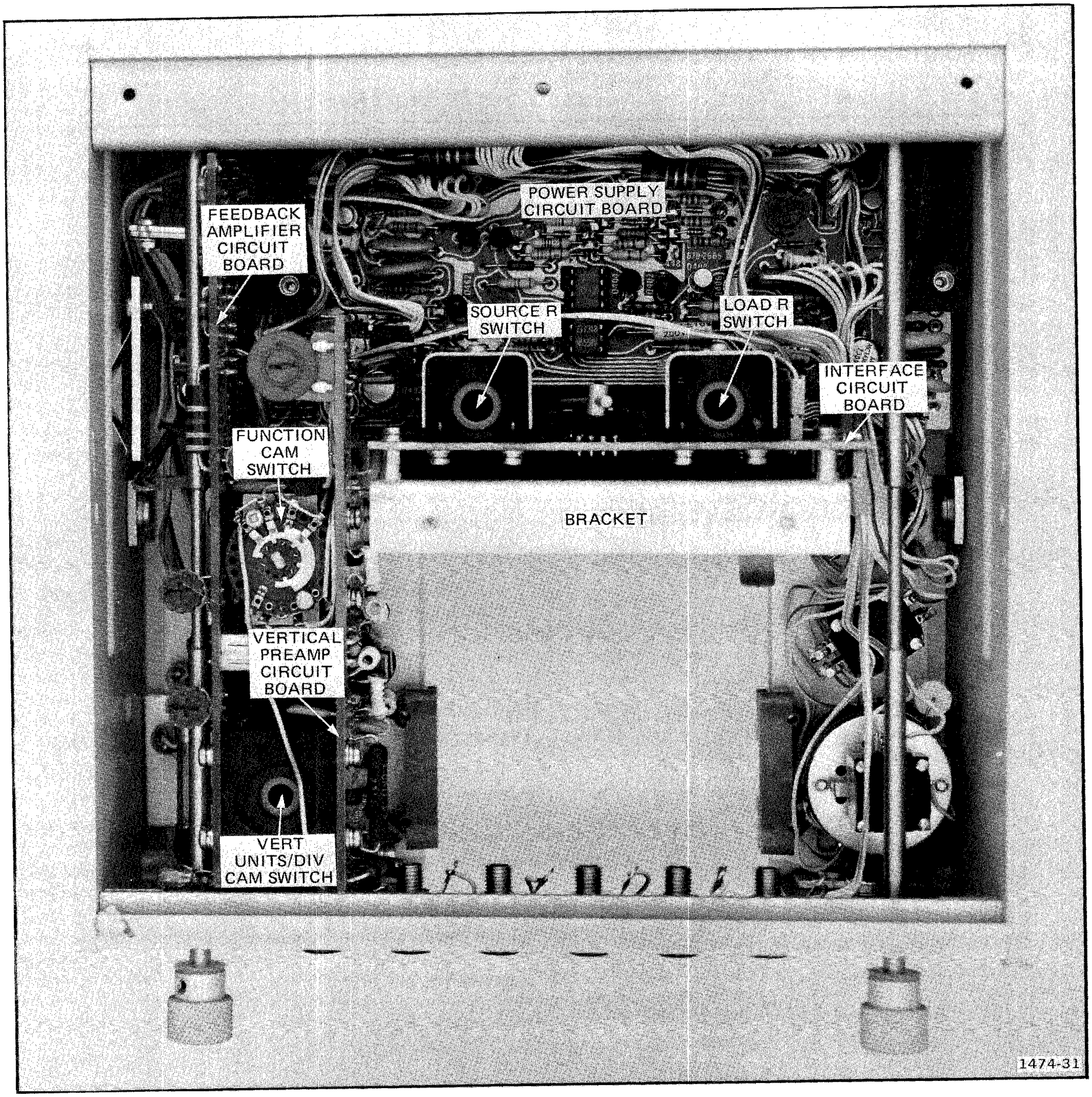

POWER SUPPLY CIRCUIT BOARD
FEEDBACK AMPLIFIER CIRCUIT BOARD
SOURCE R SWITCH
LOAD R SWITCH
INTERFACE CIRCUIT BOARD
FUNCTION CAM SWITCH
BRACKET
VERTICAL PREAMP CIRCUIT BOARD
VERT UNITS/DIV CAM SWITCH
1474-31

Fig. 4-5. Location of circuit boards in the 178.

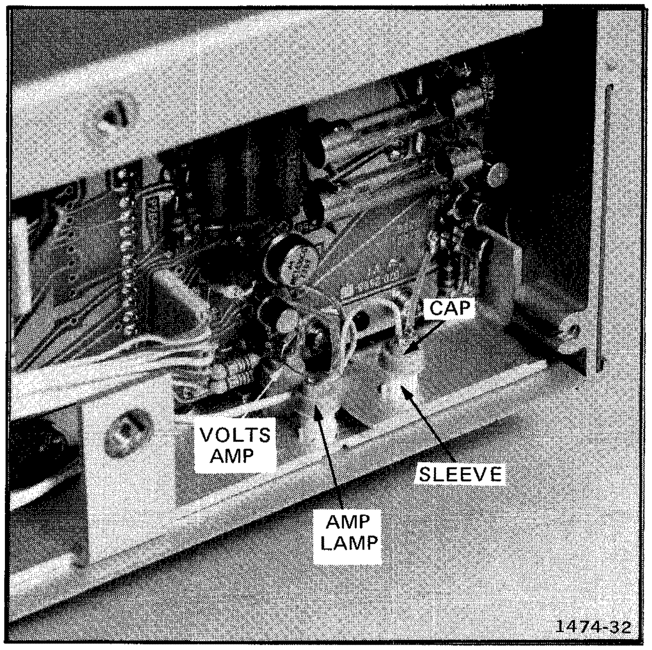


Fig. 4-6. Location and assembly details of indicator lamps.

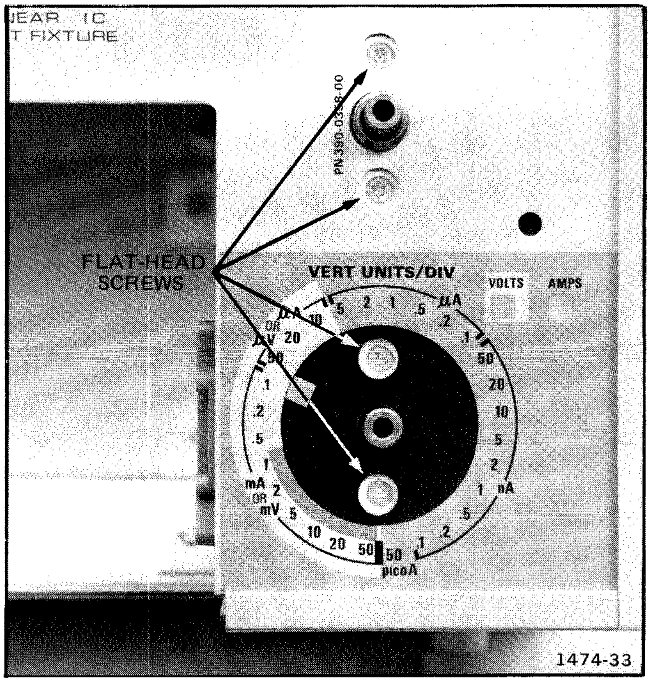


Fig. 4-7. Location of the flat-head machine screws under FUNCTION and VERT UNITS/DIV switches.

f. Remove the four flat-head screws (visible through the front-panel openings, see Fig. 4-7) at the VERT UNITS/DIV and FUNCTION switches.

g. Loosen the socket-head screw from the DUT SUPPLIES switch arm (see Fig. 4-8).

h. Remove the three multi-pin connectors from the Interface circuit board.

i. Remove the DUT card-grounding clip (see Fig. 4-9).

j. Remove the two hex nuts (that hold the bracket to the main chassis) near the 60-pin interface connector.

k. Lift the Vertical Preamp, Feedback Amp, and Interface circuit boards away from the instrument, as a unit.

l. Separate the two board assemblies lying at right angles by pulling the Interface board away from the double-board assembly.

Removing and Replacing the Feedback and Vert Preamp Boards from the Cam-Switch Assembly

If the two boards (Feedback Amplifier and Vertical Preamp) common to the FUNCTION and VERTical UNITS/DIV switches must be separated, remove only one board at a time from the cam switch drum-and-bearing assembly. The drum-and-bearing assembly is precisely aligned at the factory. If both boards are removed from this assembly, the alignment is destroyed. If both boards must be removed, do not disassemble until the replacement boards are obtained. Replace one board at a time to preserve the alignment.

Cam Switch Repair and Replacement

A cam switch is actually an assembly consisting of a cam rotated by a front panel control and a set of contacts on an adjacent circuit board.

If the cam in the cam-switch drum-and-bearing assembly must be replaced, do not remove the assembly from the circuit boards until the replacement cam assembly is obtained. An alignment fixture and installation instructions are included with the replacement cam assembly.

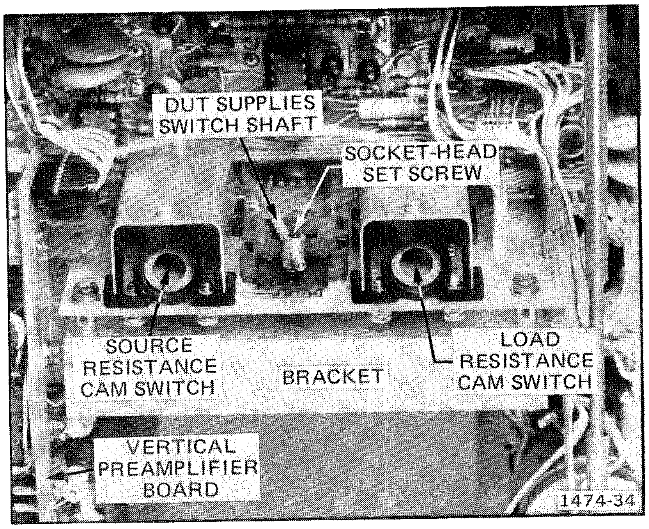

DUT SUPPLIES SWITCH SHAFT
SOCKET-HEAD SET SCREW
SOURCE RESISTANCE CAM SWITCH
BRACKET
LOAD RESISTANCE CAM SWITCH
VERTICAL PREAMPLIFIER BOARD
1474-34

Fig. 4-8. Location of the DUT SUPPLIES switch arm.

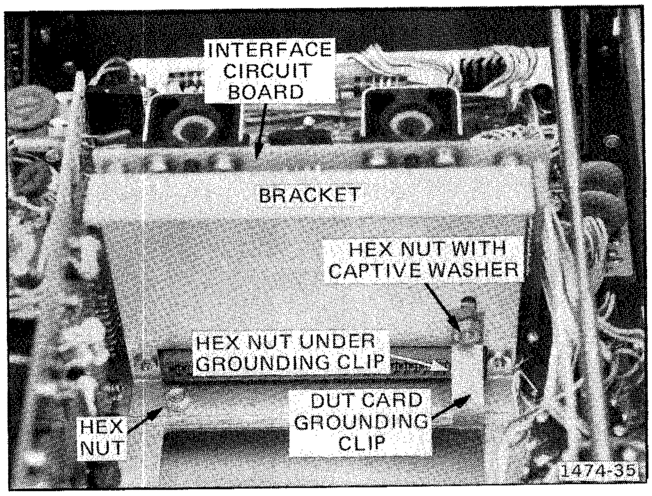

INTERFACE CIRCUIT BOARD
BRACKET
HEX NUT WITH CAPTIVE WASHER
HEX NUT UNDER GROUNDING CLIP
DUT CARD GROUNDING CLIP
HEX NUT
1474-35

Fig. 4-9. Location of the DUT card grounding clip.

CAUTION

Repair of cam switches should be undertaken only by experienced repair personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance in repair of the cam switches, contact your local Tektronix Field Office or representative.

Cleaning. If the contact is not obviously damaged, try cleaning it before replacing. Follow the cleaning procedures in the order given; the first ones are the easiest.

CAUTION

When cleaning cam switch contacts:

1. Don't use cleaners, detergents, or lubricants which leave a residue. The residue can interfere with the high-frequency response of the contact. Also, the residue will attract dust and cause the contact to require frequent cleaning.

2. Don't use any cleaners which contain fluorocarbons. These will damage the cam portion of the switch. Fluorocarbons also damage the circuit board material used in some instruments.

3. Don't use anything that could snag the contact, like a cotton swab.

4. Don't scrape the pad. If the gold is removed from the pad, the pad will oxidize and cause future problems.

5. Don't bend the contacts. This may temporarily fix the problem. However, bending the contact damages its self-cleaning action and causes problems in the future.

Use the following procedures to clean the contacts:

1. Operate the switch several times. The wiping action may clean the contacts.

2. Blow low pressure air in the area of the contact while operating the switch.

3. Flush the contact with isopropyl alcohol and blow dry with low-pressure air. Isopropyl alochol is flammable; avoid its use near open flame or other potential sources of ignition.

If the above procedures don't work, replace the contact strip. If cleaning the switch restores continuity, check to ensure that the contact wipes across the pad. If the contact does not wipe, replace the contact strip.

Contact Replacement. Cam Switch contacts in this instrument are part of a contact strip assembly. Refer to the mechanical parts list for ordering information.

If you do not have a replacement contact strip assembly, bend the contact for a temporary repair. If you do bend the contact, make note of its location and the symptom it causes. This will speed repair if the contact fails before you can make permanent repair.

Removal of Storage Compartment Shields

Preliminary

1. Remove the two flat-head machine screws (Fig. 4-10) from the bottom panel.

2. Remove the two round-head machine screws (Fig. 4-11) at the front of the storage compartment.

Removal-Right Shield

1. Press lightly at the point on the shield indicated in Fig. 4-12.

2. Grasp the upper-right corner of the shield and tilt the top of the shield toward the center of the instrument while lifting the shield upward.

3. When the bottom of the shield clears the hex nut on the bottom panel, swing the front of the shield toward the instrument center, and lift the shield away from the instrument.

Removal-Left Shield

1. Press lightly at the point on the shield indicated in Fig. 4-12.

2. Grasp the upper-left corner of the shield and tilt the top of the shield slightly toward the instrument center while lifting the shield to clear the hex nut on the bottom panel.

3. Swing the front of the shield toward the center while pulling forward on the shield, until the shield clears the grounding clip (Fig. 4-12).

4. Lift the shield from the instrument.

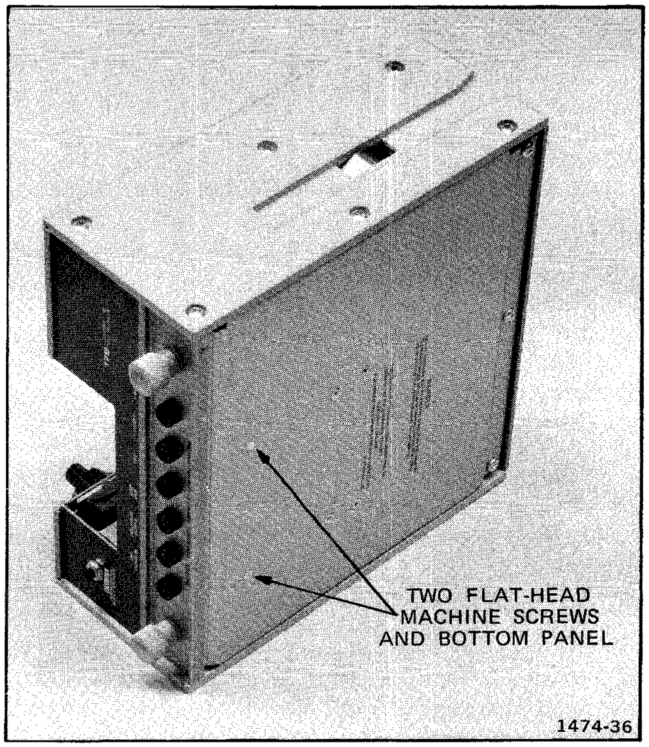


Fig. 4-10. Location of the screws securing the storage compartment shield.

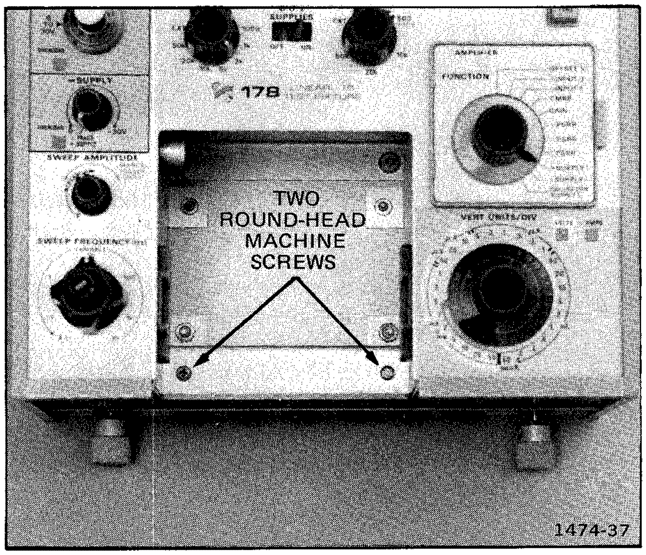


Fig. 4-11. Location of the screws in the storage compartment.

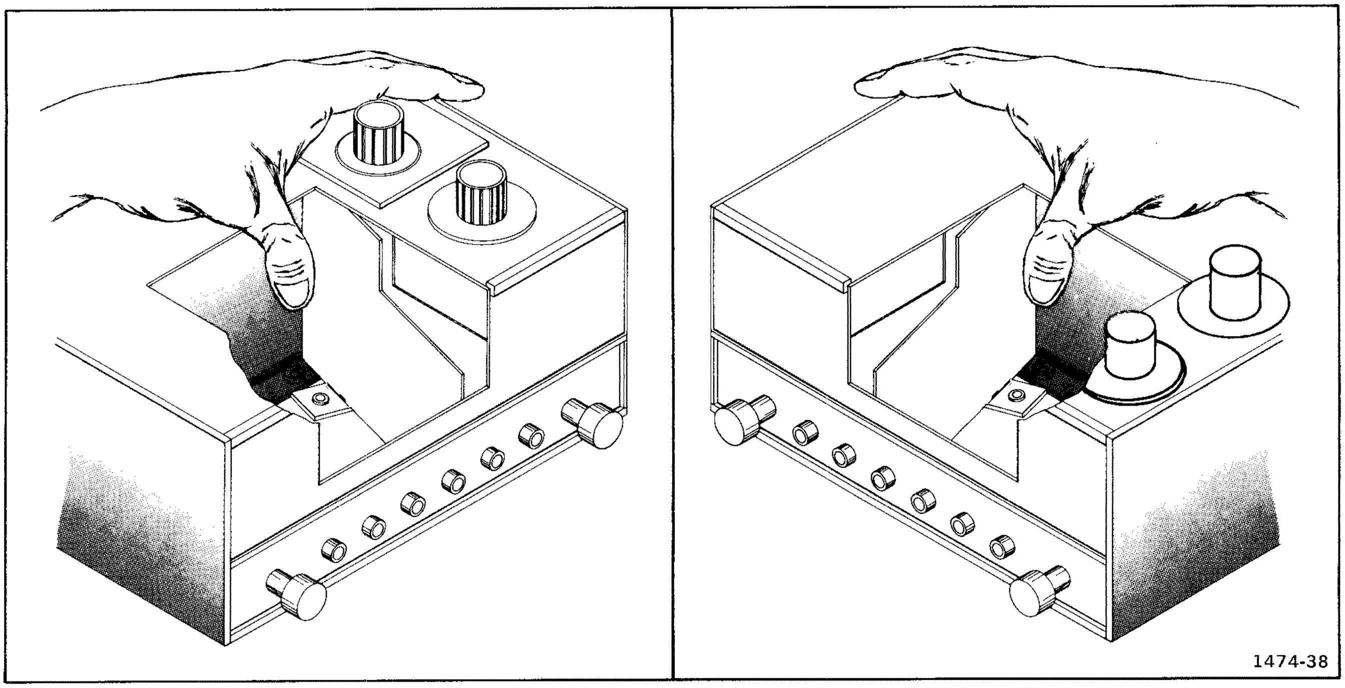


Fig. 4-12. Removing the storage compartment shields.

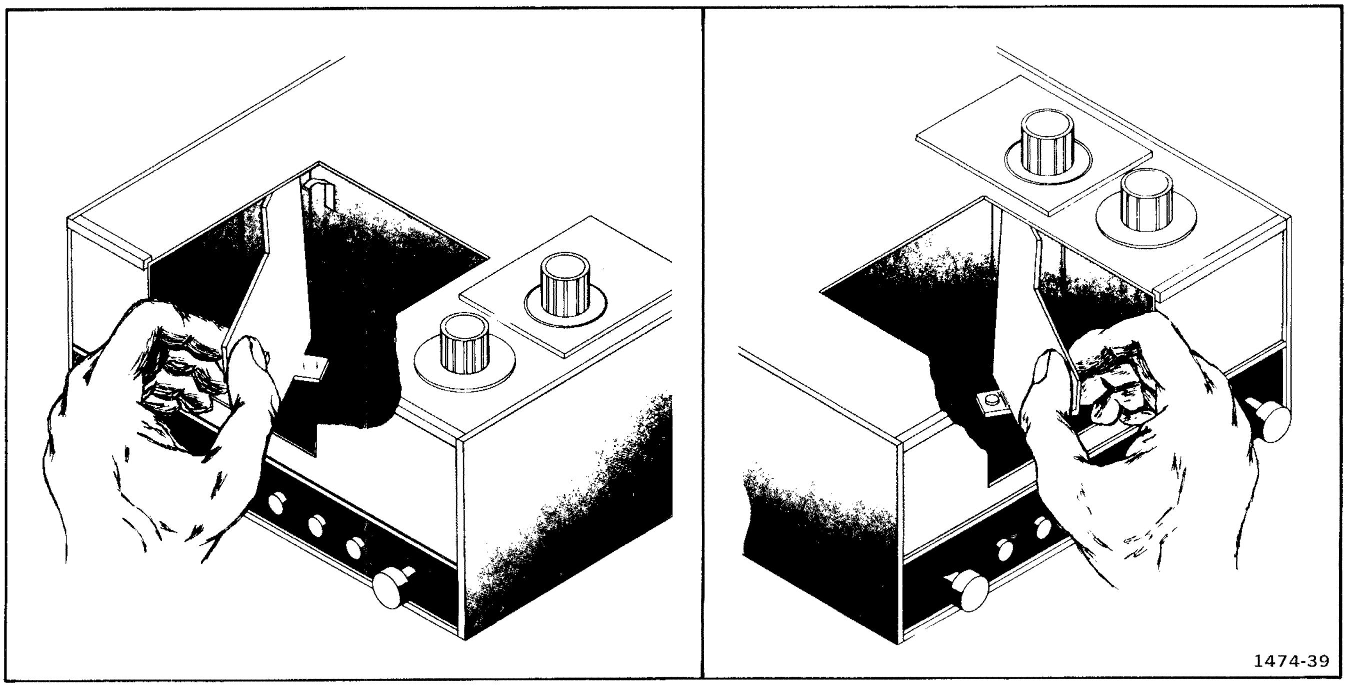


Fig. 4-13. Replacement of the storage compartment shields.

Replacement of Storage Compartment Shield-Left Side

1. Place the shield in the instrument as shown in Fig. 4-13, with the back edge to the left of the grounding clip.

2. Tilt the top of the shield slightly toward the instrument center, while swinging the front of the shield toward its final position.

3. When the bottom of the shield clears the hex nut on the bottom panel, slide the shield into position and place the round-head machine screw through the front tab, but do not tighten.

4. Replace the flat-head screw through the bottom panel into the shield and tighten. Tighten the round-head machine screw at the front of the compartment.

Replacement of Storage Compartment Shield-Right Side

1. Place the shield into the compartment as shown in Fig. 4-13.

2. Grasp the upper-left corner of the shield and tilt the top of the shield slightly toward the instrument center.

3. Keeping the shield tilted, swing the front end of the shield toward its final position, lifting slightly to clear the hex nut on the bottom panel.

4. Place the round-head screw through the front tab, Fig. 4-13, but do not tighten.

5. Replace the flat-head machine screw through the bottom panel into the shield and tighten. Tighten the round-head machine screw at the front of the compartment.

PERFORMANCE CHECK/ADJUSTMENT PROCEDURE

Introduction

This section of the manual contains separate check and adjustment procedures. The Check procedure is provided to check the instrument operation against the instrument specification. The adjustment procedure is used to return the instrument to the original performance capabilities. Adjustment is generally required after a repair has been made, or after a long time interval in which normal aging of components may affect instrument accuracy.

Services Available

Tektronix, Inc. provides complete instrument repair and calibration service at local field service centers and field offices. Contact your local Tektronix Field Office or representative for further information.

Test Equipment Required

The following test equipment, or equivalent, is required for a complete check or adjustment of the 178 Linear IC Test Fixture. All test equipment is assumed to be correctly calibrated and operating within the listed specifications.

1. Digital Ohmmeter or Resistance Bridge: range, 50 Ω through 50 kΩ; accurate within 0.1%.

2. Differential dc Voltmeter: input resistance, 1000 MΩ; range, 0 through 4 volts; accurate within 0.1%. A digital voltmeter may be used for some of the measurements in these procedures. Use the differential voltmeter where indicated.

3. Test Oscilloscope: dual input, dc coupled; time/div, .1 ms through 1 s; deflection factor, from .5 V/Div. (10 μV/Div, differential input, for CMRR test method 3, optional.)

4. Time Mark Generator: markers at 1 ms, .1 s, 1 s, and 5 s. The TEKTRONIX TG 501 Time Mark Generator is recommended.

5. Test Op Amp: CMRR 150 dB specified minimum or 120 dB measured; noise level less than 2 μV with 50 Ω source resistance; Tektronix calibration fixture 067-0756-00 is recommended. See CMRR test method 1 in the procedure.

Or, CMRR 110 dB specified minimum; noise level less than 2 μV with 50 Ω source resistance; any op amp meeting or exceeding 114 dB measured, such as the Precision Monolithic OP-05EJ, may be used. See CMRR test mehtod 2 in the procedure.

6. Two LM301 IC operational amplifiers. One is supplied as a standard accessory.

7. Resistor Kit (Tektronix Calibration Fixture 067-0691-00). Same as the calibration resistor kit for the 177.

1-1 Ω, 3 W, 1/4%
1-10 Ω, 3 W, 1/4%
1-100 Ω, 1/2 W, 1/4%
2-200 Ω, 10 W, 1%
1-1 kΩ, 1/4 W, 1/4%
1-10 kΩ, 1/4 W, 1/4%
1-100 kΩ, 1/8 W, 1/4%
1-1 MΩ, 1/8 W, 1/4%
1-10 MΩ, 1/8 W, 1/4%

Order if needed, for the 178, one-100 MΩ, 1 W, 1/4% resistor (Tektronix Calibration Fixture 067-0705-00).

8. Capacitor. 0.22 μF, 50 volts.

9. Other components, for building CMRR test circuit for method 2:

2-50 kΩ, 1/4%
1-40.2 kΩ, 1%
2-1.5 kΩ, 5%
1-10 kΩ potentiometer
2-10-volt zener diodes

10. Extender cable (to permit making adjustments to the 178 without removing the 577 bottom panel). Tektronix Part No. 067-0721-00.

PERFORMANCE CHECK

1. Check Source Resistance Accuracy

a. With the 178 removed from the 577, set the 178 controls as follows:

FUNCTION	OFFSET V
VERT UNITS/DIV	1 m
SOURCE RESISTANCE	50 Ω

b. Connect an ohmmeter or resistance bridge (accuracy .1%) between the +IN and GND terminals on the Standard Op Amp DUT card. Set the SOURCE RESISTANCE and VERT UNITS/DIV switches to the first settings in Table 5-1.

c. CHECK—The resistance and tolerance should be as shown in Table 5-1.

d. Switch to the next settings in Table 5-1.

e. CHECK—The resistance value for each of the SOURCE RESISTANCE and VERT UNITS/DIV settings should be within the tolerances shown.

Table 5-1

SOURCE RESISTANCE	VERT UNITS/DIV[a]	Ohmmeter Reading	Tolerance
50 Ω	1 m	550 Ω	Check for approx value only[b]
50 Ω	.5 m	50 Ω	
10 k	.5 m	10 kΩ	±1%
20 k	.5 m	20 kΩ	±1%
50 k	.5 m	50 kΩ	±1%

If a more accurate measurement is required, use the following method:

Connect the points on the DUT card, shown in Fig. 5-1, to GND and slide the EXT Feedback Amp switch away from the NORM position. Measure the resistance as in parts b through e. Return the slide switch to NORM and remove the connecting leads.

NOTE

Using this method a zero ohm reading is normal when measuring from + to ground in the 50Ω source resistor position.

f. Connect the ohmmeter or resistance bridge between −IN and GND on the Op Amp card and repeat steps a through e.

g. Connect the ohmmeter between −IN and the left $-R_S$ EXT terminal. Set the SOURCE RESISTANCE switch to EXT.

h. CHECK—The meter should indicate a short circuit.

i. Connect the ohmmeter between GND and the right $-R_S$ EXT terminal.

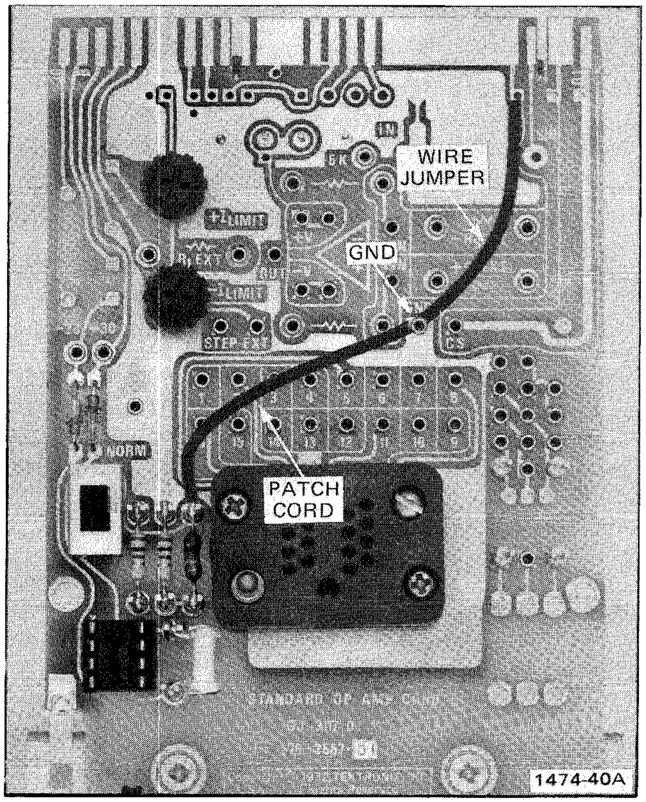


Fig. 5-1. Connections necessary for accurate measurement of source resistance (see Table 5-1, footnote 2).

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[a] **When the VERT UNITS/DIV switch is in the 1 m/DIV to 50 m/DIV positions, add 500 Ω to the SOURCE RESISTANCE indicated.**

[b] **The measured resistance varies, depending upon the ohmmeter and resistance range used, because of the Source Resistance protection circuit in the 178. Use the highest range possible consistent with good resolution.**

j. CHECK—The ohmmeter should indicate approximately 50 Ω.

k. Connect the ohmmeter between GND and the right $+R_S$ EXT terminal.

l. CHECK—The ohmmeter should indicate approximately 50 Ω.

m. Connect the ohmmeter between +IN and the left $+R_S$ EXT terminal.

n. CHECK—The ohmmeter should indicate a short circuit.

2. Check Load Resistance Accuracy

a. Set the controls as follows:

577

Power	in (off)

178

FUNCTION	OFFSET V
LOAD RESISTANCE	100 Ω
SWEEP AMPLITUDE	
+SUPPLY	0.0 (zero)
−SUPPLY	Track +Supply

b. Connect a lead from GND to the sixth hole to the left from the upper-right corner of the Standard Op Amp card. See Fig. 5-2.

NOTE

Grounding this point permits measuring these resistors without removing the right-side cover. The resistance measured is higher (on the higher ranges) than indicated on the LOAD RESISTANCE switch. This difference is shown in Table 5-2.

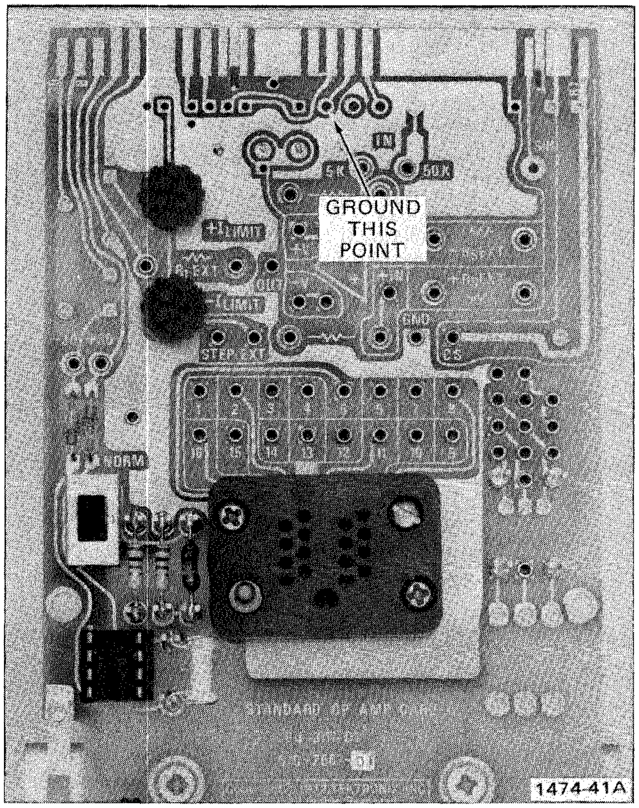


Fig. 5-2. Location of the point to be grounded in Step 2, part b.

c. Place the Standard Op Amp card (DUT card) in the 178 and plug the 178 into the 577.

d. Connect the ohmmeter between GND and OUT on the DUT card.

e. Switch the FUNCTION switch to each of its positions.

f. CHECK—The meter reads 100 Ω only on the OFFSET V and GAIN positions. All other positions should read approximately 50 kΩ.

g. Return the FUNCTION switch to OFFSET V.

h. CHECK—Using Table 5-2, read the value of resistance for each setting of the LOAD RESISTANCE switch.

Table 5-2

LOAD RESISTANCE Switch Setting	Resistance in Ohms	Tolerance
100 Ω	100	±3 Ω
1 k	1.001 k	±30 Ω
2 k	2.006 k	±60 Ω
5 k	5.039 k	±150 Ω
10 k	10.156 k	±302 Ω
20 k	20.60 k	±606 Ω
50 k	54.20 k	±1.54 kΩ
EXT	54.20 k	±1.54 kΩ

i. Set the LOAD RESISTANCE switch to EXT.

j. CHECK—With the Ohmmeter connected between OUT and the right end of R_L EXT on the DUT card; the meter should read a short circuit.

k. Remove the ground lead from the Standard Op Amp card.

3. Check Vertical Preamp Balance

a. Set the controls as follows:

577

Max Peak Volts	6.5
Variable Collector %	0
Series Resistors	.12
Horiz Volts/Div	200 V, Collector
Horizontal Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Display Filter Norm	out
Vertical Position	out (Mag On) centered
Power	on

178

FUNCTION	−INPUT I
VERT UNITS/DIV	5 m (magnified)
SWEEP FREQUENCY (Hz)	.1
SWEEP AMPLITUDE	ccw

b. Press and hold the DISPLAY ZERO button. Position the spot to near the graticule center and note the spot position.

c. Release the DISPLAY ZERO button.

d. CHECK—The spot should shift not more than 2 divisions, ±50 pA (from the position noted in part b) when switched through all vertical ranges.

4. Check Vertical Looping (Optional)

a. Set the controls as follows:

577

Max Peak Volts	25
Variable Collector %	100
Collector Supply Polarity	AC
Horiz Volts/Div	10 V, Collector
Horizontal Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	out (Magnified) centered

178

FUNCTION	COLLECTOR SUPPLY I
VERT UNITS/DIV	2 mA (magnified)
DUT SUPPLIES Switch	ON

b. CHECK—Typically vertical separation (looping) of the trace is less than 1 division on the .1 mA to 50 mA ranges.

5. Check Vertical Current-Mode Accuracy

a. Set the controls as follows:

577

Max Peak Volts	6.5
Variable Collector %	0
Series Resistors	.12
Horiz Volts/Div	200 V, Collector
Collector Supply Polarity	AC

All Dark Gray Buttons and Knobs in except:

Display Filter	
Norm	out
Step Family	Single
Horizontal Position	centered
Vertical Position	centered
Offset Mult	
Zero (button)	in
Aid (button)	in
Step/Offset Ampl	50 mA
Offset Mult (dial)	0.00

178

FUNCTION	COLLECTOR SUPPLY I
VERT UNITS/DIV	50 m
SWEEP FREQUENCY (Hz)	1 k
SWEEP AMPLITUDE	fully counterclockwise
DUT SUPPLIES Switch	ON
SOURCE RESISTANCE	50 Ω

b. Connect the 10 Ω, 1/4%, 3-watt resistor (shown in Table 5-3) between STEP and CS terminals on the Op Amp Dut card. Connect a digital dc voltmeter across the 10 Ω resistor. The meter must float (meter common to the STEP terminal). See footnotes a and b for Table 5-1.

c. Note the digital voltmeter reading. Vertically and horizontally position the spot to top-center graticule lines.

d. Push to release the Offset Zero button to the out position. Set the Offset Mult dial to position the spot to the bottom graticule line.

e. CHECK—The dc voltmeter should indicate within 4.00 volts (±3%) of the voltage noted in part c.

f. Set the VERT UNITS/DIV and Step/Offset Ampl to the next settings in Table 5-3. Push the Offset Zero button in and repeat steps c and d.

g. CHECK—The voltmeter reading should be within the voltage limits set in column 4 (with the voltage noted in part c as the reference).

h. Continue the tests using Table 5-3, using the resistor values shown in column 3, through 50 nA/DIV.

i. Starting with 20 nA/DIV, use a differential dc voltmeter. Set the FUNCTION Selector to −INPUT I.

Table 5-3

VERT UNITS/ DIV	STEP/ OFFSET AMPL	Resistor Value	Meter Reading	Limit (3%)
50 mA	50 mA	10 Ω	4.00 V	±0.12 V
20 mA	20 mA		1.60 V	±0.048 V
10 mA	10 mA		0.80 V	±0.024 V
5 mA	5 mA	100 Ω	4.00 V	±0.12 V
2 mA	2 mA		1.60 V	±0.048 V
1 mA	1 mA		0.80 V	±0.024 V
.5 mA	.5 mA	1 kΩ	4.00 V	±0.12 V
.2 mA	.2 mA		1.60 V	±0.048 V
.1 mA	.1 mA		0.80 V	±0.024 V
50 μA	50 μA	10 kΩ	4.00 V	±0.12 V
20 μA	20 μA		1.60 V	±0.048 V
10 μA	10 μA		0.80 V	±0.024 V
5 μA	5 μA	100 kΩ[a]	4.00 V	±0.12 V
2 μA	2 μA		1.60 V	±0.048 V
1 μA	1 μA		0.80 V	±0.024 V
.5 μA	.5 μA	1 MΩ[a]	4.00 V	±0.12 V
.2 μA	.2 μA		1.60 V	±0.048 V
.1 μA	.1 μA		0.80 V	±0.024 V
50 nA	50 nA		0.40 V	±0.012 V

[a] If a dc voltmeter having an input impedance of less than 1000 MΩ is used to measure the voltage accross the 100 kΩ and 1 MΩ resistors, the reading will be in error depending on the meter impedance. To calculate the correct voltage, use the formula:

$$V_2 = V_1 \frac{R_m}{R_m + R_s}$$

Where,

V_2 is correct voltage
V_1 is indicated voltage
R_m is meter impedance
R_s is the current-sensing resistor in the table.

Table 5-3 (cont)

Use a differential voltmeter for the remaining measurements (see part j)

VERT UNITS/ DIV	STEP/ OFFSET AMPL	Resistor Value	Meter Reading	Limit (3%)
20 nA	.2 V	10 MΩ[b]	1.60 V	±0.048 V
10 nA	.1 V		0.80 V	±0.024 V
5 nA	.05 V		0.40 V	±0.012 V
2 nA	.2 V	100 MΩ[b]	1.60 V	±0.048 V
1 nA	.1 V		0.80 V	±0.024 V
.5 nA	.05 V		0.40 V	±0.012 V
.2 nA	.05 V		0.16 V	±0.0048 V
.1 nA	.05 V		0.08 V	±0.0024 V
50 pA	.05 V		0.04 V	±0.0012 V

[b]A shielded cable can be used to reduce noise on these measurements. Connect the shield to the Step terminal on the DUT card and to the voltmeter common (do not ground).

j. Connect the resistor between DUT STEP and −IN terminals. Set the Offset Mult dial to 0.00. Zero the differential dc voltmeter.

k. Connect the differential voltmeter common terminal to the DUT STEP terminal and the ±voltmeter terminal to the DUT −IN terminal. This minimizes noise pickup.

l. Adjust the Offset Mult dial for a zero-volt reading on the voltmeter. Opposing the offset aid (Aid button in the out position) may have to be used.

m. Position the spot to the top graticule line.

n. Disconnect the differential voltmeter positive terminal.

o. Adjust the Offset Mult dial to position the spot to the bottom graticule line (in Offset Aid).

p. Reconnect the voltmeter and set the meter dials for a meter null.

q. CHECK—The differential meter should read voltage as indicated in Table 5-3.

r. Continue the tests as described in parts j through p for the remainder of the switch positions.

6. Check Vertical Voltage Accuracy

a. Set the controls as follows:

577

Horiz Volts/Div	5 V, Collector

All Dark Gray Buttons and Knobs in except:

Step Family	Single

178

SWEEP FREQUENCY (Hz)	.1
SWEEP AMPLITUDE	pull
+SUPPLY	15.0 V
−SUPPLY	TRACK +SUPPLY
LOAD RESISTANCE	50 k
SOURCE RESISTANCE	20 k
DUT SUPPLIES	OFF
FUNCTION	GAIN
VERT UNITS/DIV	50 m

b. Connect the test socket on the DUT card for an op amp, such as a 741 or LM301. Place the op amp in the test socket.

c. Connect a 1 MΩ resistor between OUT and −IN. Connect a patch cord between +R, top end, and R_F, top end. Set the External Feedback Amplifier switch, the slide switch on the DUT card, away from the NORM position.

d. Connect a digital voltmeter (dvm) or dc bridge between GND and the patch cord between +R and R_F. Set the DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button. Center the dot with the Vert Pos control.

e. Turn the MANUAL SWEEP control until the spot on the crt is on the bottom graticule line. Note the meter reading.

f. Turn the MANUAL SWEEP control until the spot is on the top graticule line. Note the meter reading.

g. CHECK—The sum of the readings noted in parts e and f should be as shown in Table 5-4, column 3.

h. Switch the VERT UNITS/DIV switch to 20 m and SOURCE RESISTANCE to 10 k.

i. Press the DISPLAY ZERO button. Turn the MANUAL SWEEP control to set the spot to the bottom graticule line. Note the voltage reading.

j. Turn the MANUAL SWEEP control to set the spot to the top graticule line. Note the voltage reading.

k. CHECK—The sum of the readings noted in parts i and j should be as shown in Table 5-4, column 3.

Table 5-4

VERT UNITS/ DIV	SOURCE RESISTANCE	Sum of the Voltages	Accuracy
50 m	20 k	4.00 V	±120 mV
20 m	10 k	1.60 V	± 40 mV

l. Replace the 1 MΩ resistor on the DUT card with a 10 MΩ resistor.

m. CHECK—Using Table 5-5 and the procedure in parts i and j, check the accuracy at the VERT UNITS/DIV settings in column 1.

Table 5-5

VERT UNITS/ DIV	SOURCE RESISTANCE	Sum of the Voltages	Accuracy
10 m	50 k	0.8 V	±24 mV
5 m	20 k	0.4 V	±12 mV
2 m	10 k	0.16 V	±4.8 mV
1 m	10 k	0.08 V	±2.4 mV

n. Remove the patch cords and resistors, then set the External Feedback Amplifier switch to NORM.

7. Check Sample and Hold Offset Voltage Range

a. Set the controls as follows:

577

Variable Collector %	0
Max Peak Volts	100
Collector Supply Polarity	AC
Series Resistors	2 M
Step/Offset Ampl	.5 V
Offset Mult (dial)	1.00
AID	IN

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Offset Zero	out
Horizontal Position	pull (X10 Mag) centered
Pulsed 300 μs	out
Vertical Position	centered
Horiz Volts/Div	10 mV, Collector (Mag on)

178

VERT UNITS/DIV	10 μA
FUNCTION	COLLECTOR SUPPLY I
SOURCE RESISTANCE	50 Ω
DUT SUPPLIES	OFF

b. Connect a patch cord between OUT and STEP on the Standard Op Amp card. Connect a patch cord between +IN and CS.

c. Switch DUT SUPPLIES switch to ON.

d. Press and hold the DISPLAY ZERO button and position the spot approximately to horizontal graticule center. Note the spot position and release the DISPLAY ZERO button.

e. CHECK—The spot should shift ⩾2.5 divisions to the left of the position noted in part d.

f. Release the AID button on the 577 to the Oppose position.

g. Press the DISPLAY ZERO button.

h. CHECK—The spot should shift ⩾2.5 divisions to the right of the position noted in part d.

i. Remove the patch cords from the Standard Op Amp card.

8. Check Power Supplies

a. Set the controls as follows:

577

Horiz Volts/Div	10 V, Collector
Vertical Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single

178

FUNCTION	OFFSET V
+SUPPLY	fully counterclockwise
−SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
SWEEP FREQUENCY (Hz)	.1
VERT UNITS/DIV	50 mV
DUT SUPPLIES Switch	ON
SOURCE RESISTANCE Switch	50 Ω

Standard Op Amp Card

Limits	fully clockwise

b. Connect the dvm between +SUPPLY and GND on the front panel. Read the voltage on the dvm.

c. CHECK—The +SUPPLY dial should indicate approximately the voltage read on the dvm in part b.

d. Reconnect the dvm between +SUPPLY and −SUPPLY on the front panel. Set +SUPPLY dial to 30.0.

e. CHECK—The voltage should be 60.0 volts, ±0.6 volt (1%).

f. Set the DUT SUPPLIES switch to OFF. Connect a 200 Ω, 10 watt, 1% resistor from +V to GND on the Standard Op Amp card. Connect the dvm across the 200 Ω resistor and set the DUT SUPPLIES switch to ON.

g. CHECK—For +30 volts, ±2%, ±100 mV.

h. Set the DUT SUPPLIES switch to OFF. Reconnect the 200 Ω resistor between −V and GND. Switch the DUT SUPPLIES switch to ON. Read the voltage across the 200 Ω.

i. CHECK—For −30 volts, ±2%, ±100 mV.

j. Set the DUT SUPPLIES switch to OFF. Remove the 200 Ω resistor. Patch from +V to GND on the Standard Op Amp card. Set the FUNCTION switch to +SUPPLY I. Set the DUT SUPPLIES switch to ON.

k. Press the DISPLAY ZERO button and position the spot to the graticule bottom center (zero reference). Release the DISPLAY ZERO button and set the DUT SUPPLIES switch to ON.

l. CHECK—For approximately 4 divisions of vertical shift from the zero reference (approximately 200 mA). Note that the +SUPPLY OVERLOAD lamp is lighted.

m. CHECK—That when the +I Limit control (on the Standard Op Amp card) is turned counterclockwise, the +Supply current decreases (spot moves toward the zero reference).

n. Set the DUT SUPPLIES switch to OFF. Move the patch cord from +V to −V. Set the FUNCTION switch to −SUPPLY I.

o. Press the DISPLAY ZERO button and position the spot to the graticule top center (zero reference). Release the DISPLAY ZERO button and set the DUT SUPPLIES switch to ON.

p. CHECK—For approximately 4 divisions of vertical shift from the zero reference (approximately 200 mA). Note that the −SUPPLY OVERLOAD lamp is lighted.

q. CHECK—That when the −I Limit control is turned counterclockwise, the −Supply current decreases (spot moves toward the zero reference). Remove the jumper.

9. Check Sweep Generator

a. Set the 577-178 controls as follows:

577

Horiz Volts/Div	5 V, Collector
Horizontal Position	centered
Vertical Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single

178

FUNCTION	+SUPPLY I
+SUPPLY	30.0
−SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	midrange
SWEEP FREQUENCY (Hz)	1 k
VARIABLE	fully clockwise (X1)
DUT SUPPLIES	OFF
VERT UNITS/DIV	.5 mA

Test Oscilloscope

Vert Mode	Alt
CH 1 DC	5 V/Div
CH 2 DC	.5 V/Div
Position CH 1 and 2	centered
Time/Div	.1 ms
Trigger Mode	Norm
Slope	+
Coupling	DC

Time Mark Generator

Marker Selector	1 ms

b. Connect the time mark generator to CH 2 of the test oscilloscope. Connect +V on the Standard Op Amp card to CH 1 of the oscilloscope. Set the DUT SUPPLIES switch to ON. Trigger the test oscilloscope for a stable display.

c. Position the first time mark to the left graticule line on the test oscilloscope. Note the point at which the sine wave from the 178 crosses the time mark from the time mark generator.

d. CHECK—That the sine wave crosses the right-most time mark at the same point as noted in part c, ±0.5 major horizontal division.

e. Set the SWEEP FREQUENCY to 100 Hz and the test oscilloscope Horizontal to 1 ms/Div.

f. CHECK—For 1 cycle in 10 time marks, ±0.5 div.

g. Set the SWEEP FREQUENCY to 10 Hz. Set the time mark generator to .1 s. Set the test oscilloscope to 10 ms/Div.

h. CHECK—For 1 cycle in 1 time mark, ±0.5 div.

i. Set the test oscilloscope for .1 s/Div[1] and the time mark generator to 1 s. Set the test oscilloscope to CH 2 only and check the display for 1 time mark/10 horizontal divisions. If not 1 time mark/10 divisions, adjust the horizontal Variable for 1 mark/10 divisions.

j. Set the test oscilloscope vertical to CH 1. Set the 178 SWEEP FREQUENCY control to 1 s.

k. CHECK—For 1 cycle in 10 divisions, ±0.5 division.

l. Set the oscilloscope to 1 s/Div (use variable if necessary). Switch the test oscilloscope vertical to CH 2. Set the time mark generator to 1 s and check the time base for 10 s in 10 divisions.

m. Set the test oscilloscope vertical to CH 1. Set the 178 SWEEP FREQUENCY to .1.

n. CHECK—For 1 cycle in 10 divisions, ±0.5 division.

o. Set the test oscilloscope horizontal to 2 s/Div. Set the SWEEP FREQUENCY to 1 and the SWEEP FREQUENCY VARIABLE TO X.1.

p. CHECK—The sine wave on the test oscilloscope for 5 divisions, +0.25 to 2 divisions.

q. Set the SWEEP FREQUENCY to 10 Hz. Set the test oscilloscope horizontal for .2 s/Div. Set the test oscilloscope horizontal variable to Cal.

r. CHECK—Display for 1 cycle in 5 divisions, +0.25 to +2 divisions, minus the test scope accuracy[2].

s. Set the SWEEP FREQUENCY to 100 Hz. Set the test oscilloscope horizontal for 20 ms/Div.

t. CHECK—The display for 1 cycle in 5 divisions, +0.25 to +2 divisions, minus the test oscilloscope accuracy[2].

u. Set SWEEP FREQUENCY to 1 k and test oscilloscope horizontal to 2 ms/Div and repeat part t.

v. Set SWEEP FREQUENCY to .1. Set the time mark generator to 5 s. Disconnect the test oscilloscope. Connect the time mark generator through a .22 μF, 50 V capacitor to +V on the Standard Op Amp card. Set the 178 VERT UNITS/DIV to .1 mA. Position the trace on screen[3].

w. Turn on the storage. When the trace is at about midsweep (approximately 15 V) erase the trace and count the number of time marks in one full sine-wave cycle.

x. CHECK—For 21 pulses, ±7 pulses in one cycle.

10. Check Sweep Amplitude

a. Set the controls as follows:

577

Horiz Volts/Div	2 V, Collector

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	Pull (Mag On) centered

---

[1] If the test oscilloscope goes to only .5 s, use the Horizontal Variable and the time mark generator at 1 s and calibrate the crt for 1 time mark/division.

[2] The test oscilloscope accuracy can be checked with the time mark generator. If the sine wave is off the graticule to the right, move the right time mark 2 divisions to the left with the horizontal position control.

[3] Another method of checking part v is to use a stop watch or a watch with a sweep second hand and check for 100 seconds/cycle.

178

+SUPPLY	30.0 V
−SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	0 (fully counterclockwise)
MANUAL SWEEP	UP (pull out)
SOURCE RESISTANCE	50Ω
FUNCTION	CMRR
VERT UNITS/DIV	20 μV
DUT SUPPLIES Switch	OFF

b. Connect the DVM between -IN and ground on the Standard Op Amp card.

c. Turn the DUT SUPPLIES Switch to ON.

d. CHECK—the voltage should be +30 ±0.9 V.

11a. Check COMMON-MODE REJECTION RATIO, METHOD 1[4]

a. Set the controls as follows:

577

Horiz Volts/Div	2 V, Collector

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	Pull (Mag On) centered

178

SWEEP FREQUENCY (Hz)	1
VARIABLE	X1 (clockwise)
+SUPPLY	15.0 V
−SUPPLY	TRACK +SUPPLY
DUT SUPPLIES Switch	OFF
SOURCE RESISTANCE	50 Ω
FUNCTION	CMRR
VERT UNITS/DIV	.1 m (magnified)

b. Using patch cords, connect the test Op Amp[4] on the Standard Op Amp card. Set the DUT SUPPLIES switch ON. Press the DISPLAY ZERO button.

c. Set the SWEEP AMPLITUDE control for 10 divisions of horizontal display.

d. CHECK—Vertical deflection of the horizontal trace should not exceed ±3 divisions.

e. Set the VERT UNITS/DIV switch to 10 μV (magnified). Press the DISPLAY ZERO button.

f. CHECK—Vertical deflection of the horizontal trace should not exceed ±3 divisions.

g. Set the VERT UNITS/DIV switch to 1 μV (magnified). Press the DISPLAY ZERO button.

h. CHECK—Vertical deflection of the horizontal trace should not exceed ±3 divisions.

11b. Check COMMON-MODE REJECTION RATION, METHOD 2

a. Set the controls as follows:

577

Horiz Volts/Div	2 V, Collector
Horizontal Position	centered
Power Switch	in (off)

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	pull (Mag On) centered

178

FUNCTION	CMRR
SOURCE RESISTANCE	50 Ω
+SUPPLY	15.0 V
−SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
SWEEP FREQUENCY (Hz)	10
VARIABLE	X1 (clockwise)
VERT UNITS/DIV	.1 m (magnified)
DUT SUPPLIES Switch	OFF

b. Construct the circuit of Fig. 5-3 on the Standard Op Amp card. This method uses an op amp having good cmrr and drives its terminals common mode, thereby improving the op amp cmrr to ≈160 to 180 dB.

c. Plug the Standard Op Amp card into the 178. Pull the 577 Power switch.

d. Set the 178 DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button and position the spot to graticule ccenter. Turn the SWEEP AMPLITUDE control clockwise to display 10 divisions of horizontal trace.

e. Adjust the Output Terminal cmrr control (on the test circuit) for no trace looping.

f. CHECK—Vertical deflection of the horizontal trace should not exceed ±1.5 divisions.

g. Set the VERT UNITS/DIV to 10 μV (Mag On) and press the DISPLAY ZERO button. Adjust the Output Terminal CMRR control for no trace looping.

h. CHECK—Vertical deflection of the horizontal trace should not exceed ±1.5 divisions.

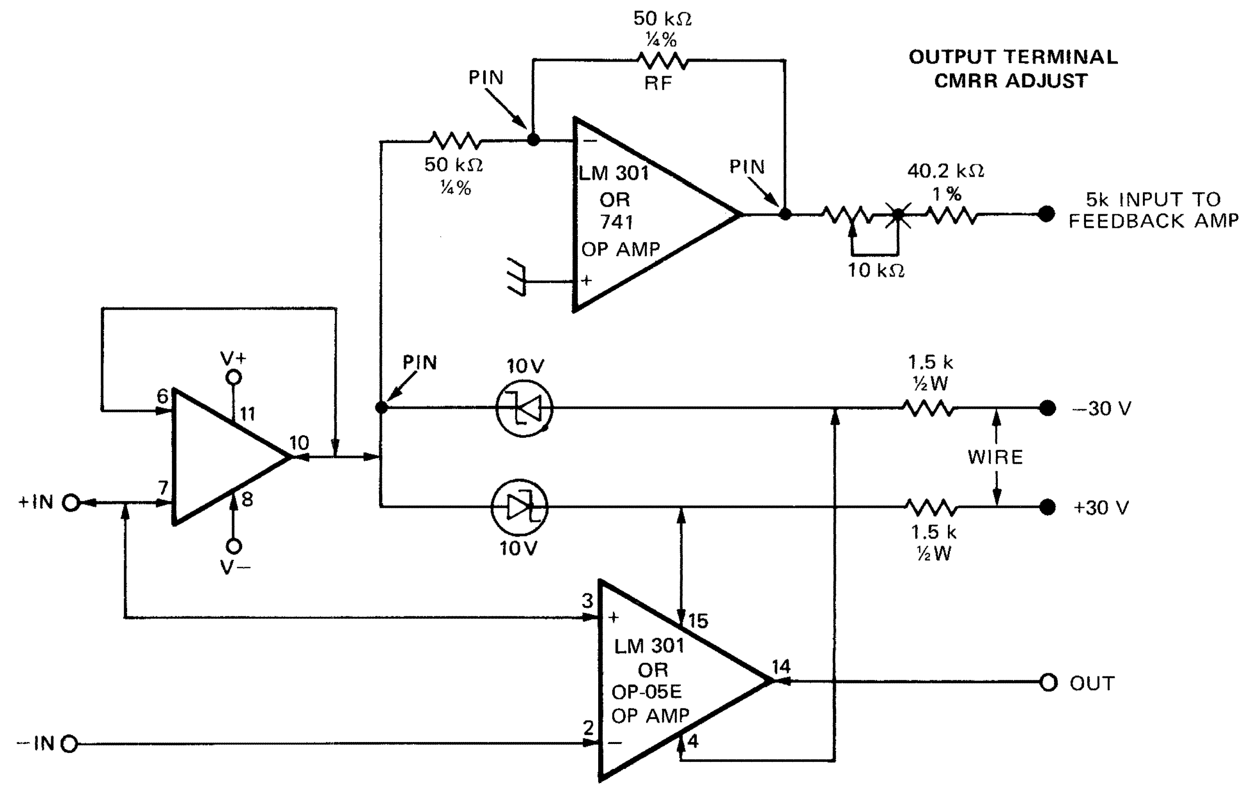
i. Set the VERT UNITS/DIV switch to 1 μV (Mag On) and press the DISPLAY ZERO button. Adjust the Output Terminal CMRR control for no trace looping.

---

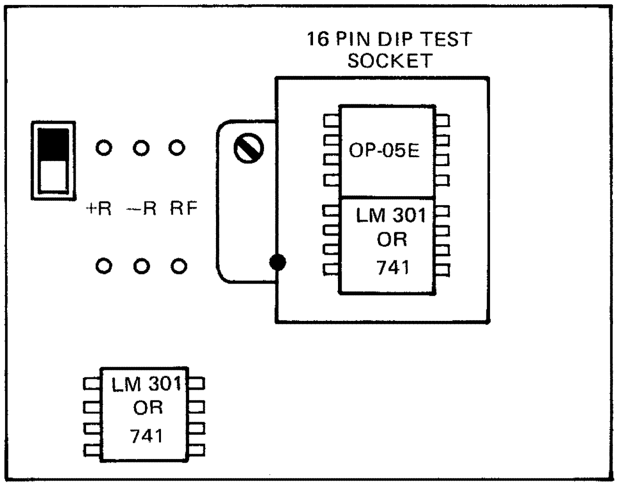
[4] CMRR of the test op amp must be 150 dB, specified minimum, or must be ⩾120 dB, measured. The noise level must be less than 2 μV, using 50 Ω source resistance. Tektronix calibration fixture 067-0756-00 is recommended. Precision Monolithics SS725 also meets the 120 dB requirement. Compensate the SS725 for X1 gain according to manufacturer's specification.

↔	PATCH CORD
● ←PIN	BIFURCATED TERMINAL PIN
○	HOLE IN CIRCUIT BOARD (SOLDER)
×	WIRED CONNECTION (SOLDER)

THE SOCKET PIN NUMBERS SHOWN ARE TEST SOCKET NUMBERS FOR THE OP AMPS SHOWN. IF OTHER TYPES ARE USED, THE SOCKET NUMBERS MAY BE DIFFERENT.


50 kΩ
¼%
RF
PIN
OUTPUT TERMINAL
CMRR ADJUST
50 kΩ
¼%
LM 301
OR
741
OP AMP
PIN
40.2 kΩ
1%
10 kΩ
5k INPUT TO
FEEDBACK AMP
V+
PIN
10V
1.5 k
½W
−30 V
6
11
10
WIRE
+IN
7
8
10V
+30 V
1.5 k
½W
V−
3
15
LM 301
OR
OP-05E
OP AMP
14
OUT
−IN
2
4

THE OP-05E OP AMP USED IN THIS TEST IS A LOW NOISE DEVICE HAVING A MINIMUM SPEC OF 110 dB. ANY OP AMP MEETING OR EXCEEDING 114 dB MAY BE USED. ALL WIRING SHOWN IS IN ADDITION TO THAT ON THE STANDARD OP AMP CARD. IF OTHER THAN A LOW NOISE DEVICE IS USED, THERE MAY BE CONSIDERABLE JOHNSON NOISE. THE OP-05E TYPICALLY DISPLAYS 1 to 2 μV OF NOISE IN THIS TEST.


16 PIN DIP TEST
SOCKET
OP-05E
+R −R RF
LM 301
OR
741
LM 301
OR
741

1474-45A

Fig. 5-3. Test circuit for CMRR adjust.

j. CHECK—Vertical deflection of the horizontal trace should not exceed ±1.5 divisions.

k. Remove patch cords and components from the Standard Op Amp card.

ADJUSTMENT PROCEDURE

1. Adjust Vertical Preamplifier Balance

a. Set the controls as follows:

577

Max Peak Volts	6.5
Variable Collector %	0
Series Resistors	.12
Horiz Volts/Div	200 V, Collector
Horizontal Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Display Filter Norm	out
Vertical Position	pull (Mag On) centered

178

FUNCTION	COLLECTOR SUPPLY I
VERT UNITS/DIV	5 m (magnified)
SWEEP FREQUENCY (Hz)	.1
SWEEP AMPLITUDE	0

b. Press and hold the DISPLAY ZERO button. Position the spot to or near to graticule center and note the spot position.

c. Set the VERT UNITS/DIV to 5 pA and press and hold the DISPLAY ZERO button.

d. ADJUST—R340, Vertical Preamp Balance, for no spot movement while switching between 5 mA and 5 pA. See Fig. 5-4 for location of R340.

e. Release the DISPLAY ZERO button. Set the VERT UNITS/DIV switch to 5 pA. Wait 15 seconds.

f. ADJUST—R310, Converter Balance, to position the spot to the point noted in part b.

2. Adjust Vertical Looping

a. Set the controls as follows:

577

Max Peak Volts	25
Variable Collector %	100
Collector Supply Polarity	AC
Horiz Volts/Div	10 V, Collector
Horizontal Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	pull (Mag On) centered

178

FUNCTION	COLLECTOR SUPPLY I
VERT UNITS/DIV	2 mA (magnified)
DUT SUPPLIES Switch	ON

b. ADJUST—R315, Vertical Looping, for minimum vertical trace separation (looping). See Fig. 5-4 for location of R315.

3. Adjust Feedback Amplifier and Sample and Hold

a. Set the controls as follows:

577

Horiz Volts/Div	5 V, Collector
Horizontal Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	Pulled and centered
Display Filter	out

178

FUNCTION	CMRR
SOURCE RESISTANCE	50 Ω
+SUPPLY	+15 V
−SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
DUT SUPPLIES Switch	OFF
VERT UNITS/DIV	5 μ (magnified)

b. Press and hold the DISPLAY ZERO button. Adjust Vertical POSITION to position the spot to graticule center. Release the DISPLAY ZERO button.

c. Patch GND to OUT on the Standard Op Amp card.

d. ADJUST—R229, Feedback Bal, to position the spot to graticule center.

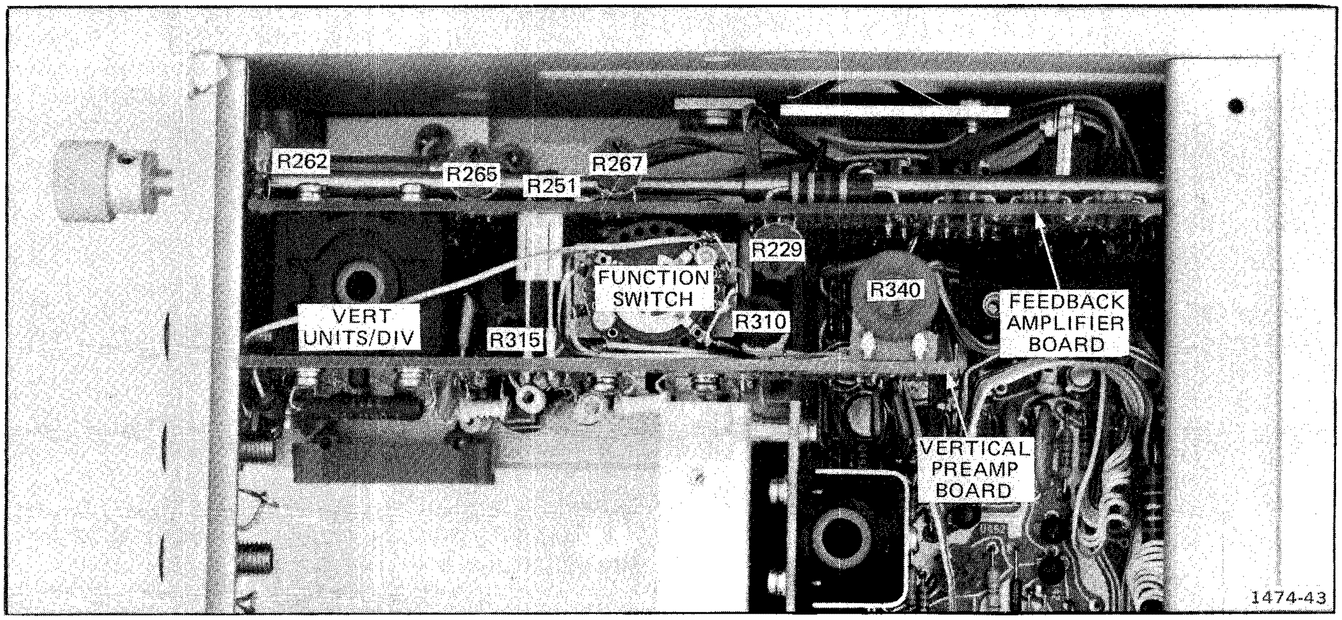


Fig. 5-4. Location of adjustments on the Vertical Preamp and Feedback Amplifier board.

e. Remove the patch cord from GND. Patch the test socket terminals to the Op Amp terminals on the Standard Op Amp card for a 741 Op Amp. (Refer to the operator's manual for instructions.) Place the 741 in the test socket.

f. Set the DUT SUPPLIES switch to ON.

g. Press the DISPLAY ZERO button. Note the spot position and release the button.

h. ADJUST—R251, Sample and Hold Bal, to locate the spot to the position noted in part g. Repeat parts g and h until there is no spot movement while pressing and releasing the DISPLAY ZERO button.

i. Remove the patch cords and 741 op amp.

4. Adjust Power Supplies

a. Set the controls as follows:

577

Horiz Volts/Div	10 V, Collector
Vertical Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single

178

FUNCTION	OFFSET V
+SUPPLY	fully counterclockwise
−SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
SWEEP FREQUENCY (Hz)	.1
VERT UNITS/DIV	50 mA
DUT SUPPLIES Switch	ON

Standard Op Amp Card

Limits	fully clockwise

b. Connect the dvm between the +SUPPLY and GND banana jacks on the front panel. Note the voltage on the dvm, approximately ±0.1 V or less.

c. Mechanically (loosen +SUPPLY knob set-screw) position the knob to the voltage noted in part b (voltage indicated on knob when the shaft is in the fully counterclockwise position).

d. Reconnect the dvm between +SUPPLY and −SUPPLY on the front panel. Set the +SUPPLY knob to 30.0.

e. ADJUST—R562, Supply Cal, for 60.0 volts. See Fig. 5-5 for location.

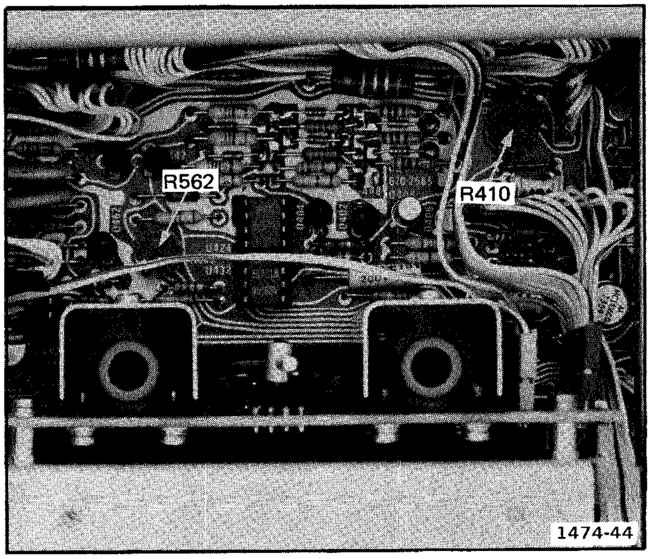


Fig. 5-5. Location of R562 and R410.

5. Adjust Sweep Generator

a. Set the 577-178 controls as follows:

577

Horiz Volts/Div	5 V, Collector
Horizontal Position	centered
Vertical Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single

178

FUNCTION	+SUPPLY I
+SUPPLY	30.0
−SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	midrange
SWEEP FREQUENCY (Hz)	100
VARIABLE	fully clockwise (X1)
DUT SUPPLIES	OFF
VERT UNITS/DIV	.5 mA

Test Oscilloscope

Vert Mode	Add
Trigger Source	CH 1
CH 1	5 V/Div
CH 2	.5 V/Div
Coupling (both)	DC
Position CH 1 and 2	centered
Time/Div	10 ms
Triggering	Norm, +slope, DC coupling, internal

Time Mark Generator

Marker Selector	10 ms

b. Connect the +V on the Standard Op Amp card to CH 1 of the test oscilloscope. Set the DUT SUPPLIES switch to ON. Trigger the test oscilloscope for a stable display. Note: CH 1 may have to be readjusted to obtain a better display.

c. Adjust Sweep Freq Adj. R410, for one cycle per division. See Fig. 5-5 for location.

d. Connect the time mark generator to CH 2 of the test oscilloscope.

e. Set the oscilloscope Time/Div to 2 ms.

f. ADJUST—R410, Sweep Freq, for minimum horizontal drift between the time mark and the sine wave.

g. Disconnect all cables.

6A. Adjust Common-Mode Rejection Ratio, Method 1[5]

a. Set the controls as follows:

577

Horiz Volts/Div	2 V, Collector

All Dark Gray Buttons and Knobs in except:

Vertical Position	pull (Mag On) centered

178

SWEEP FREQUENCY (Hz)	1
VARIABLE	X1 (clockwise)
+SUPPLY	+15.0
−SUPPLY	TRACK +SUPPLY
DUT SUPPLIES Switch	OFF
SOURCE RESISTANCE	50 Ω
FUNCTION	CMRR
VERT UNITS/DIV	.1 m (magnified)
SWEEP AMP	midrange

b. Using patch cords, patch the test op amp[5] (test socket terminals) to the op amp terminals on the Standard Op Amp card. Place the test op amp[5] in the test socket. Set the DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button. Set the SWEEP AMPLITUDE control for a 10-division trace.

[5] CMRR of the test op amp must be ⩾150 dB, minimum, or must be ⩾120 dB, measured. The noise level must be less than 2 μV using 50 Ω source resistance. Precision Monolithics SS725 meets the 120 dB specification. Compensate the SS725 for X10 gain according to manufacturers specification.

c. ADJUST—R267, X10 CMRR (see Fig. 5-4 for location), for no vertical deflection of the horizontal trace.

d. Set the VERT UNITS/DIV switch to 10 μV (Mag on) and press the DISPLAY ZERO button.

e. ADJUST—R265, X100 CMRR, for no vertical deflection of the horizontal trace.

f. Set the VERT UNITS/DIV to .1 m (Mag On) and press the DISPLAY ZERO button and repeat parts c through f until there is no vertical deflection of the horizontal trace.

g. Set the VERT UNITS/DIV to 1 μV (Mag On) and press the DISPLAY ZERO button.

h. ADJUST—R262, X1000 CMRR for no vertical deflection of the horizontal display.

6B. Adjust Common-Mode Rejection Ratio, Method 2

a. Set the controls as follows:

577

Horiz Volts/Div	2 V, Collector
Horizontal Position	centered
Power Switch	in (off)

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	pull (Mag On) centered

178

FUNCTION	CMRR
SOURCE RESISTANCE	50 Ω
+SUPPLY	15.0 V
−SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
SWEEP FREQUENCY (Hz)	10
VARIABLE	X1 (clockwise)
VERT UNITS/DIV	1. m (magnified)
DUT SUPPLIES Switch	OFF

b. Construct the circuit of Fig. 5-6 on the standard Op Amp card. This method uses an op amp having good CMRR and drives its terminals common mode, thereby improving the op amp cmrr to ≈160 to 180 dB.

c. Plug the Standard Op Amp card into the 178. Pull the 577 Power switch.

d. Set the 178 DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button and position the spot to graticule center. Turn the SWEEP AMPLITUDE control clockwise to display 10 divisions of horizontal trace.

e. Adjust the Output Terminal CMRR control (on the test circuit) for no trace looping.

f. ADJUST—R267, X10 CMRR (see Fig. 5-4) for no vertical deflection of the horizontal trace.

g. Set the VERT UNITS/DIV to 10 μV (magnified) and press the DISPLAY ZERO button. Adjust the Output Terminal CMRR control for no trace looping.

h. ADJUST—R265, X100 CMRR, for no vertical deflection of the horizontal trace.

i. Set the VERT UNITS/DIV to .1 mV and press the DISPLAY ZERO button. Repeat parts e through i until there is no vertical deflection.

j. Set the VERT UNITS/DIV to 1 μV (magnified) and press the DISPLAY ZERO button. Adjust the Output Terminal CMRR Adjust for no looping.

k. ADJUST—R262, X1000 CMRR, for no vertical deflection of the horizontal trace.

6C. Adjust Common-Mode Rejection Ratio, Method 3

a. Set the controls as follows:

577

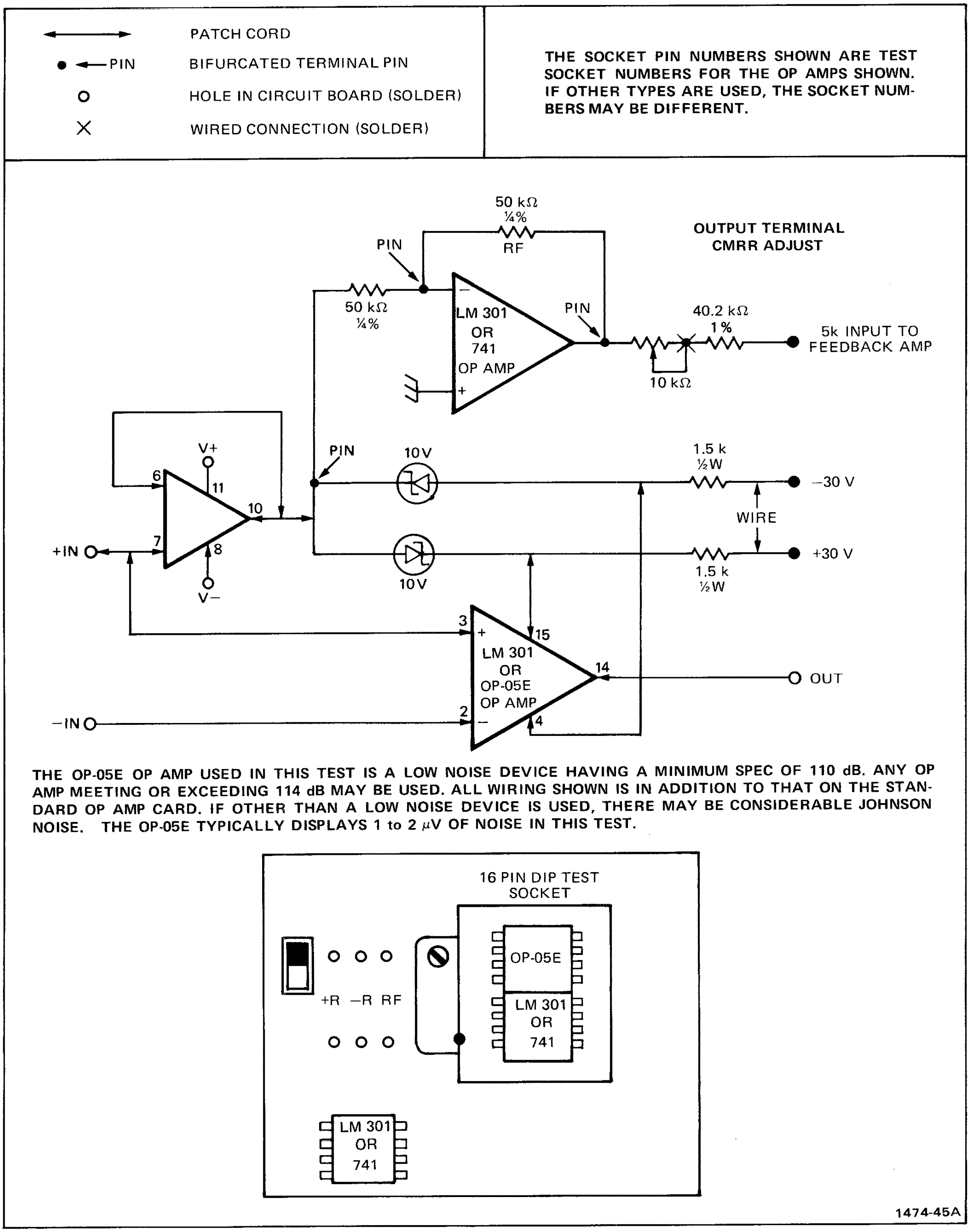
Horiz Volts/Div	2 V, Collector

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	pull (Mag On) centered

178

SWEEP FREQUENCY (Hz)	1
VARIABLE	X1 (fully clockwise)
+SUPPLY	15.0 V
−SUPPLY	TRACK +SUPPLY
SOURCE RESISTANCE	50 Ω
FUNCTION	CMRR
VERT UNITS/DIV	.1 m (Mag On)
DUT SUPPLIES Switch	OFF



↔	PATCH CORD
● ←PIN	BIFURCATED TERMINAL PIN
○	HOLE IN CIRCUIT BOARD (SOLDER)
×	WIRED CONNECTION (SOLDER)

THE SOCKET PIN NUMBERS SHOWN ARE TEST SOCKET NUMBERS FOR THE OP AMPS SHOWN. IF OTHER TYPES ARE USED, THE SOCKET NUMBERS MAY BE DIFFERENT.

THE OP-05E OP AMP USED IN THIS TEST IS A LOW NOISE DEVICE HAVING A MINIMUM SPEC OF 110 dB. ANY OP AMP MEETING OR EXCEEDING 114 dB MAY BE USED. ALL WIRING SHOWN IS IN ADDITION TO THAT ON THE STANDARD OP AMP CARD. IF OTHER THAN A LOW NOISE DEVICE IS USED, THERE MAY BE CONSIDERABLE JOHNSON NOISE. THE OP-05E TYPICALLY DISPLAYS 1 to 2 μV OF NOISE IN THIS TEST.

50 kΩ
¼%
RF
PIN
OUTPUT TERMINAL
CMRR ADJUST
50 kΩ
¼%
LM 301
OR
741
OP AMP
PIN
40.2 kΩ
1%
5k INPUT TO
FEEDBACK AMP
10 kΩ
V+
6
11
10
+IN
7
8
V−
PIN
10V
1.5 k
½W
−30 V
WIRE
+30 V
1.5 k
½W
10V
3
15
LM 301
OR
OP-05E
OP AMP
14
OUT
2
4
−IN
16 PIN DIP TEST
SOCKET
OP-05E
LM 301
OR
741
+R −R RF
LM 301
OR
741
1474-45A

Fig. 5-6. Test circuit for CMRR adjust.

b. Using patch cords, patch the test op amp (test socket terminals) to the op amp terminals on the Standard Op Amp card. Place the test op amp in the test socket. Set the DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button.

c. Set the SWEEP AMPLITUDE to display 10 divisions of horizontal deflection.

d. ADJUST—R267, X10 CMRR (see Fig. 5-4 for location), for no vertical deflection of the horizontal trace.

e. Set the VERT UNITS/DIV switch to 10 μV (Mag On) and press the DISPLAY ZERO button.

f. ADJUST—R265, X100 CMRR, for no vertical deflection of the horizontal trace.

g. Set the VERT UNITS/DIV switch to .1 mV (Mag On). Press the DISPLAY ZERO button and repeat parts d through f until there is no vertical deflection of the horizontal trace. If the cmrr is not 120 dB, but is a known (recorded) value, adjust the cmrr to the known value.

h. Remove the test op amp from the Standard Op Amp card.

i. Reset the controls as follows:

178

VERT UNITS/DIV	1 μV (Mag On)
FUNCTION	GAIN
SWEEP AMPIITUDE	fully counterclockwise

Differential Input Test Oscilloscope

Vertical Input	10 μV, DC
Horizontal Time/Div	5 ms
Trigger	Auto
Probes	X1, identical lead length

or

In lieu of a test scope, use a dvm having
1 μV resolution

j. Connect a lead between the R_F terminal (upper end) and the third hole from the left of the upper-right corner of the DUT card. Keep the lead short.

k. Press the DISPLAY ZERO button. Switch the External Feedback selector (to the left of the test socket, see Fig. 5-6), away from the NORM position.

l. Connect both test oscilloscope probes (or the DVM) to −IN on tthe DUT card, using a bifurcated pin terminal. Twist the probe leads together to minimize noise.

m. Note the dc voltage level. Connect one of the probes (or one of the dvm leads) to the +IN terminal on the DUT card.

n. ADJUST—R262, X1000 CMRR, for the dc level noted in part m.

NOTE

Performing parts i through n calibrate the 50 μV, 20 μV, and 10 μV (5 μV, 2 μV, and 1 μV with magnifier on) ranges. If the X10 CMRR or X100 CMRR controls are re-adjusted, the X1000 range is no longer calibrated and parts i through n must be repeated.

o. This completes the Adjustment Procedure.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00213	NYTRONICS, COMPONENTS GROUP, INC., SUBSIDIARY OF NYTRONICS, INC.	ORANGE STREET	DARLINGTON, SC 29532
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03888	KDI PYROFILM CORPORATION	60 S JEFFERSON ROAD	WHIPPANY, NJ 07981
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
10389	CHICAGO SWITCH, INC.	2035 WABANSIA AVE.	CHICAGO, IL 60647
14298	AMERICAN COMPONENTS, INC., AN INSILCO COMPANY	8TH AVE. AT HARRY STREET	CONSHOHOCKEN, PA 19428
14552	MICRO SEMICONDUCTOR CORP.	2830 E FAIRVIEW ST.	SANTA ANA, CA 92704
15238	ITT SEMICONDUCTORS, A DIVISION OF INTER NATIONAL TELEPHONE AND TELEGRAPH CORP.	P.O. BOX 168, 500 BROADWAY	LAWRENCE, MA 01841
17856	SILICONIX, INC.	2201 LAURELWOOD DRIVE	SANTA CLARA, CA 95054
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
55292	LEDCO DIV., WILBRECHT ELECTRONICS, INC.	240 EAST PLATO BLVD.	ST. PAUL, MN 55107
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71450	CTS CORP.	905 N. WEST BLVD	ELKHART, IN 46514
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76854	OAK INDUSTRIES, INC., SWITCH DIV.	S. MAIN ST.	CRYSTAL LAKE, IL 60014
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81073	GRAYHILL, INC.	561 HILLGROVE AVE., PO BOX 373	LA GRANGE, IL 60525
91418	RADIO MATERIALS COMPANY, DIV. OF P.R. MALLORY AND COMPANY, INC.	4242 W BRYN MAWR	CHICAGO, IL 60646
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-2568-00			CKT BOARD ASSY:INTERFACE	80009	670-2568-00
A2	670-2569-00			CKT BOARD ASSY:VERTICAL PREAMPL	80009	670-2569-00
A3	670-2566-00			CKT BOARD ASSY:FEEDBACK AMPL	80009	670-2566-00
A4	670-2565-00	B010100	B029999	CKT BOARD ASSY:POWER SUPPLY	80009	670-2565-00
A4	670-2565-01	B030000	B039999	CKT BOARD ASSY:POWER SUPPLY	80009	670-2565-01
A4	670-2565-02	B040000		CKT BOARD ASSY:POWER SUPPLY	80009	670-2565-02
A5	670-2567-00			CKT BOARD ASSY:STANDARD OP AMPL	80009	670-2567-00
C15	281-0536-00	XB030710		CAP.,FXD,CER DI:1000PF,10%,500V	72982	301000 X 5P0102K
C23	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	56289	19C242B
C25	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	56289	19C242B
C131	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C141	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C205	281-0526-00			CAP.,FXD,CER DI:1.5PF,+/-0.5PF,500V	04222	7001-1313
C208	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	91418	SP103Z151-4R9
C227	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	59660	301-055C0G0100F
C254	285-0898-00			CAP.,FXD,PLSTC:0.47UF,10%,100V	56289	LP66A1B474K
C263	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	91418	SP103Z151-4R9
C291	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C293	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C295	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C306	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C315	283-0119-00			CAP.,FXD,CER DI:2200PF,5%,200V	59660	855-536Y5E0222J
C318	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C320	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	59660	301-000U2J0470M
C322	281-0536-00			CAP.,FXD,CER DI:1000PF,10%,500V	72982	301000 X 5P0102K
C324	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C342	281-0512-00			CAP.,FXD,CER DI:27PF,+/-2.7PF,500V	59660	308-000C0G0270K
C352	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	59660	301-055C0G0100F
C359	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	91418	SP103Z151-4R9
C361	281-0546-00			CAP.,FXD,CER DI:330PF,10%,500V	04222	7001-1380
C371	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	72982	8131N031Z5U0105Z
C373	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	72982	8131N031Z5U0105Z
C406	281-0543-00			CAP.,FXD,CER DI:270PF,10%,500V	72982	301055X5P271K
C424	295-0158-00			CAP.,SET,MTCHD:0.001UF,1UF	80009	295-0158-00
C425	----- -----			(C424,C425, INDIVIDUAL TIMING CAPACITORS IN		
	----- -----			THIS ASSEMBLY MUST BE ORDERED BY THE 9-DIGIT		
	----- -----			PART NUMBER, LETTER SUFFIX AND TOLERANCE		
	----- -----			PRINTED ON THE TIMING CAPACITOR TO BE REPLACED.		
	----- -----			THE LETTER SUFFIX AND THE TOLERANCE SHOULD BE		
	----- -----			THE SAME FOR ALL OF THE TIMING CAPACITORS IN		
	----- -----			THE ASSEMBLY. EXAMPLE: 285-XXXX-XX F -)		
C442	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C452	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C472	281-0549-00			CAP.,FXD,CER DI:68PF,10%,500V	59660	301-000U2J0680K
C475	290-0522-00			CAP.,FXD,ELCTLT:1UF,20%,50V	56289	196D105X0050HA1
C476	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C482	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C484	290-0522-00			CAP.,FXD,ELCTLT:1UF,20%,50V	56289	196D105X0050HA1
C521	281-0580-00			CAP.,FXD,CER DI:470PF,10%,500V	04222	7001-1374
C542	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C549	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	59660	301-000U2J0470M
C562	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C566	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C574	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C575	290-0522-00			CAP.,FXD,ELCTLT:1UF,20%,50V	56289	196D105X0050HA1
C576	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C582	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C584	290-0522-00			CAP.,FXD,ELCTLT:1UF,20%,50V	56289	196D105X0050HA1
CR14	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	14552	TD3810983
CR18	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	14552	TD3810983
CR151	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	07263	FDH5004
CR152	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	07263	FDH5004
CR211	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR226	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR282	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR306	152-0367-00			SEMICOND DEVICE:SILICON,20V,20PA	80009	152-0367-00
CR307	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR321	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR322	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR402	152-0141-02	XB030000		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR404	152-0141-02	XB030000		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR406	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR443	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR444	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR445	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR453	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR454	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR455	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR472	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR482	152-0040-00			SEMICOND DEVICE:SILICON,600V,1A	15238	LG109
CR484	152-0040-00			SEMICOND DEVICE:SILICON,600V,1A	15238	LG109
CR492	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR493	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR494	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR520	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR532	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR533	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR572	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR582	152-0040-00			SEMICOND DEVICE:SILICON,600V,1A	15238	LG109
CR584	152-0040-00			SEMICOND DEVICE:SILICON,600V,1A	15238	LG109
CR592	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR593	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR594	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
DS236	150-0075-00			LAMP,INCAND:19V,0.0126 TO 0.0154A	08806	2149D
DS268	150-0075-00			LAMP,INCAND:19V,0.0126 TO 0.0154A	08806	2149D
DS281	150-0048-00			LAMP,INCAND:5V,60MA	08806	683
DS284	150-0048-00			LAMP,INCAND:5V,60MA	08806	683
DS286	150-0048-00			LAMP,INCAND:5V,60MA	08806	683
DS441	150-0133-00			LAMP,CARTRIDGE:14V,80MA,RED DOME LENS	55292	70106-02
DS478	150-0048-00			LAMP,INCAND:5V,60MA	08806	683
DS578	150-0048-00			LAMP,INCAND:5V,60MA	08806	683
F236	159-0083-00			FUSE,CARTRIDGE:0.15A,250V,FAST-BLOW	71400	AGC 15/100
F268	159-0083-00			FUSE,CARTRIDGE:0.15A,250V,FAST-BLOW	71400	AGC 15/100
J40	136-0140-00			JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
J50	136-0140-00			JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
J60	136-0140-00			JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
J70	136-0140-00			JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
J80	136-0140-00			JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
J90	136-0140-00			JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
Q214	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K 2N3906
Q222	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q226	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K 2N3906

151-0777-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q252A,B	151-1037-00			TRANSISTOR:SILICON,FET,N-CHANNEL	80009	151-1037-00
Q280	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q284	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487 2N2222A
Q286	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q310A,B	151-1077-00			TRANSISTOR:SILICON,JFE N- CHANNEL,DUAL	17856	DN1332 2N5908
Q402	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q404	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q406	151-0126-00			TRANSISTOR:SILICON,NPN	04713	ST1046 2N2484
Q408	151-0126-00			TRANSISTOR:SILICON,NPN	04713	ST1046
Q442	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q452	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q462	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q472	151-0126-00			TRANSISTOR:SILICON,NPN	04713	ST1046
Q478	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q484	151-0373-00			TRANSISTOR:SILICON,PNP	80009	151-0373-00
Q492	151-0103-00			TRANSISTOR:SILICON,NPN	80009	151-0103-00
Q520	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00 MSPF 789
Q536	151-0432-00			TRANSISTOR:SILICON,NPN	27014	ST07391D
Q538	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q546	151-0462-00			TRANSISTOR:SILICON,PNP	04713	TIP30C
Q548	151-0464-00			TRANSISTOR:SILICON,NPN	04713	SJE412
Q572	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q578	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q584	151-0349-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE2801	04713	SJE924
Q592	151-0235-00			TRANSISTOR:SILICON,PNP	80009	151-0235-00
R10	311-1568-00			RES.,VAR,NONWIR:50 OHM,20%,0.50W	73138	91-90-0
R14	315-0104-00	XB030710		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R15	315-0102-00	XB030710		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R16	315-0102-00	XB030710		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R20	311-1568-00			RES.,VAR,NONWIR:50 OHM,20%,0.50W	73138	91-90-0
R111	308-0545-00			RES.,FXD,WW:100 OHM,0.5%,5W	00213	1250S-100R0D
R113	308-0507-00			RES.,FXD,WW:1K OHM,1%,3W	91637	RS2B-B10000F
R115	308-0759-00			RES.,FXD,WW:2.08K OHM,1%,3W	91637	RS2B-B20800F
R116	321-0339-00			RES.,FXD,FILM:33.2K OHM,1%,0.125W	91637	MFF1816G33201F
R117	322-0264-00			RES.,FXD,FILM:5.49K OHM,1%,0.25W	75042	CEBT0-5491F
R119	321-0298-00			RES.,FXD,FILM:12.4K OHM,1%,0.125W	91637	MFF1816G12401F
R121	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R131	321-0289-01			RES.,FXD,FILM:10K OHM,0.5%,0.125W	91637	MFF1816G10001D
R132	321-0318-02			RES.,FXD,FILM:20K OHM,0.5%,0.125W	91637	CMF55116D20001D
R133	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R141	321-0289-01			RES.,FXD,FILM:10K OHM,0.5%,0.125W	91637	MFF1816G10001D
R142	321-0318-02			RES.,FXD,FILM:20K OHM,0.5%,0.125W	91637	CMF55116D20001D
R143	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R202	321-0260-01			RES.,FXD,FILM:4.99K OHM,0.5%,0.125W	91637	MFF1816G49900D
R204	321-0692-00			RES.,FXD,FILM:49.9K OHM,0.5%,0.125W	91637	MFF1816G49901D
R205	321-0692-00			RES.,FXD,FILM:49.9K OHM,0.5%,0.125W	91637	MFF1816G49901D
R206	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R208	316-0472-00			RES.,FXD,CMPSN:4.7K OHM,10%,0.25W	01121	CB4721
R214	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R216	316-0151-00			RES.,FXD,CMPSN:150 OHM,10%,0.25W	01121	CB1511
R221	316-0152-00			RES.,FXD,CMPSN:1.5K OHM,10%,0.25W	01121	CB1521
R223	315-0620-00			RES.,FXD,CMPSN:62 OHM,5%,0.25W	01121	CB6205
R224	316-0151-00			RES.,FXD,CMPSN:150 OHM,10%,0.25W	01121	CB1511
R226	304-0331-00			RES.,FXD,CMPSN:330 OHM,10%,1W	01121	GB3311
R227	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R228	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021

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R229	311-1562-00			RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91-84-0
R231 R232	325-0162-00			RES.SET,MTCHD:45K/44.8K OHM,0.1%,0.125W	91637	SPTF-30
R233 R234	325-0165-00			RES.SET,MTCHD:50/50 OHM,0.1%,0.25W	03888	A3DT38
R235 R236	325-0164-00			RES.SET,MTCHD:450/446 OHM,0.1%,0.25W	03888	A3DT37
R238 R239	325-0163-00			RES.SET.MTCHD:4.5K/4.478K OHM,0.1%,0.25W	14298	EE 1/4 (MP)
R251	311-1566-00			RES.,VAR,NONWIR:200 OHM,20%,0.50W	73138	91-88-0
R252	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	91637	MFF1816G12101F
R253	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	91637	MFF1816G12101F
R254	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R255	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R261	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R262	311-1564-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	73138	91-86-0
R263	316-0180-00			RES.,FXD,CMPSN:18 OHM,10%,0.25W	01121	CB1801
R265	311-1568-00			RES.,VAR,NONWIR:50 OHM,20%,0.50W	73138	91-90-0
R267	311-1594-00			RES.,VAR,NONWIR:10 OHM,20%,0.50W	73138	91-93-0
R271	321-0618-00			RES.,FXD,FILM:250K OHM,1%,0.125W	91637	MFF1816G25002F
R272	321-0618-00			RES.,FXD,FILM:250K OHM,1%,0.125W	91637	MFF1816G25002F
R280	316-0332-00			RES.,FXD,CMPSN:3.3K OHM,10%,0.25W	01121	CB3321
R281	316-0332-00			RES.,FXD,CMPSN:3.3K OHM,10%,0.25W	01121	CB3321
R284	316-0152-00			RES.,FXD,CMPSN:1.5K OHM,10%,0.25W	01121	CB1521
R286	316-0152-00			RES.,FXD,CMPSN:1.5K OHM,10%,0.25W	01121	CB1521
R291	307-0107-00			RES.,FXD,CMPSN:5.6 OHM,5%,0.25W	01121	CB56G5
R293	307-0107-00			RES.,FXD,CMPSN:5.6 OHM,5%,0.25W	01121	CB56G5
R295	307-0107-00			RES.,FXD,CMPSN:5.6 OHM,5%,0.25W	01121	CB56G5
R300	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R301	308-0754-00			RES.,FXD,WW:5.55 OHM,0.5%,3W	91637	RS2B-D5R550D
R302	308-0720-01			RES.,FXD,WW:50 OHM,0.5%,3W	91637	RS2B-B50R00D
R305	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R306	302-0334-00			RES.,FXD,CMPSN:330K OHM,10%,0.50W	01121	EB3341
R307	316-0393-00			RES.,FXD,CMPSN:39K OHM,10%,0.25W	01121	CB3931
R309	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R310	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91-81-0
R311	321-0995-00			RES.,FXD,FILM:549K OHM,1%,0.125W	24546	NA55D5493F
R312	321-0995-00			RES.,FXD,FILM:549K OHM,1%,0.125W	24546	NA55D5493F
R313	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R315	311-1554-00			RES.,VAR,NONWIR:200K OHM,20%,0.50W	73138	91-76-0
R316	316-0126-00			RES.,FXD,CMPSN:12M OHM,10%,0.25W	01121	CB1261
R317	316-0126-00			RES.,FXD,CMPSN:12M OHM,10%,0.25W	01121	CB1261
R318	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R321	308-0537-00			RES.,FXD,WW:1K OHM,0.5%,5W	91637	RS2A-B10000D
R322	322-0707-03			RES.,FXD,FILM:100.1K OHM,0.25%,0.25W	91637	MFF1421D10012C
R323	307-0430-00			RES.,FXD,CMPSN:11.1M OHM,1%,0.5W	03888	FL0.5-D11104F
R324	307-0429-00			RES.,FXD,CMPSN:100M OHM,1%,1W	03888	FL-1-F10005F
R329	321-0991-03			RES.,FXD,FILM:18K OHM,0.25%,0.125W	24546	NC55C1802C
R331	321-0222-03			RES.,FXD,FILM:2K OHM,0.25%,0.125W	91637	MFF1816D20000C
R333	315-0107-00			RES.,FXD,CMPSN:100M OHM,5%,0.25W	01121	CB1075
R340	311-1136-00			RES.,VAR,NONWIR:100K OHM,30%,0.25W	71450	201-YA5536
R341	316-0225-00			RES.,FXD,CMPSN:2.2M OHM,10%,0.25W	01121	CB2251
R342	316-0222-00			RES.,FXD,CMPSN:2.2K OHM,10%,0.25W	01121	CB2221
R343	321-0414-03			RES.,FXD,FILM:200K OHM,0.25%,0.125W	24546	NC55C2003C
R344	321-1609-03			RES.,FXD,FILM:2.02K OHM,0.25%,0.125W	24546	NC55C2021C
R345	321-1610-03			RES.,FXD,FILM:22.22K OHM,0.25%,0.125W	91637	MFF1816D22221C
R351	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R352	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R361	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R362	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R363	321-0631-03			RES.,FXD,FILM:12.5K OHM,0.25W,0.125W	91637	MFF1816D12501C
R401	321-0334-00			RES.,FXD,FILM:29.4K OHM,1%,0.125W	91637	MFF1816G29401F
R402	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R403	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R404	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R408	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R409	321-0287-00			RES.,FXD,FILM:9.53K OHM,1%,0.125W	91637	MFF1816G95300F
R410	311-1558-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	73138	91-80-0
R411	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
R415	311-0555-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	01121	10M985
R421	307-0381-00			RES.,FXD,FILM:4.99M OHM,1%,0.5W	03888	FLYZ 4.99M+/-1%
R422	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	91637	MFF1816G49902F
R423	321-0353-00			RES.,FXD,FILM:46.4K OHM,1%,0.125W	91637	MFF1816G46401F
R424	321-0449-00			RES.,FXD,FILM:464K OHM,1%,0.125W	91637	MFF1816G46402F
R426	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R431	321-0463-00			RES.,FXD,FILM:649K OHM,1%,0.125W	91637	MFF1816G64902F
R432	321-0367-00			RES.,FXD,FILM:64.9K OHM,1%,0.125W	91637	MFF1816G64901F
R433	316-0333-00			RES.,FXD,CMPSN:33K OHM,10%,0.25W	01121	CB3331
R441	321-0196-00			RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
R442	321-0284-00			RES.,FXD,FILM:8.87K OHM,1%,0.125W	91637	MFF1816G88700F
R443	321-0160-00			RES.,FXD,FILM:453 OHM,1%,0.125W	91637	MFF1816G453R0F
R444	321-0188-00			RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
R445	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R446	321-0612-00			RES.,FXD,FILM:500 OHM,1%,0.125W	91637	MFF1816G500R0F
R447	321-0263-00			RES.,FXD,FILM:5.36K OHM,1%,0.125W	91637	MFF1816G53600F
R448	321-0320-00			RES.,FXD,FILM:21K OHM,1%,0.125W	91637	MFF1816G21001F
R449	321-0370-00			RES.,FXD,FILM:69.8K OHM,1%,0.125W	91637	MFF1816G69801F
R451	321-0284-00			RES.,FXD,FILM:8.87K OHM,1%,0.125W	91637	MFF1816G88700F
R452	321-0196-00			RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
R453	321-0160-00			RES.,FXD,FILM:453 OHM,1%,0.125W	91637	MFF1816G453R0F
R454	321-0188-00			RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
R455	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R460	311-1310-00			RES.,VAR,NONWIR:20K OHM,20%,1W	01121	10M654
	----- -----			(R460, FURNISHED AS A UNIT WITH S460)		
R461	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
R463	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R464	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R467	321-0289-00	B010100	B019999	RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R467	321-0288-00	B020000		RES.,FXD,FILM:9.76K OHM,1%,0.125W	91637	MFF1816G97600F
R468	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
R469	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R471	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R472	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R473	308-0291-00			RES.,FXD,WW:2K OHM,5%,3W	91637	CW2B-20000J
R474	316-0822-00			RES.,FXD,CMPSN:8.2K OHM,10%,0.25W	01121	CB8221
R475	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R476	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R477	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R478	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R479	301-0111-00			RES.,FXD,CMPSN:110 OHM,5%,0.50W	01121	EB1115
R481	321-0756-03			RES.,FXD,FILM:50K OHM,0.25%,0.125W	91637	MFF1816D50001C
R482	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R483	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R484	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R485	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R486	308-0764-00			RES.,FXD,WW:2.7 OHM,5%,2W	75042	BWF-2R700J
R492	316-0123-00			RES.,FXD,CMPSN:12K OHM,10%,0.25W	01121	CB1231
R521	316-0106-00			RES.,FXD,CMPSN:10M OHM,10%,0.25W	01121	CB1061
R522	316-0222-00			RES.,FXD,CMPSN:2.2K OHM,10%,0.25W	01121	CB2221
R526	316-0224-00			RES.,FXD,CMPSN:220K OHM,10%,0.25W	01121	CB2241
R527	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R531	316-0473-00			RES.,FXD,CMPSN:47K OHM,10%,0.25W	01121	CB4731
R533	316-0473-00			RES.,FXD,CMPSN:47K OHM,10%,0.25W	01121	CB4731
R535	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R536	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R537	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R538	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R541	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R542	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R546	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R548	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R549	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	91637	MFF1816G49902F
R551	321-0356-00	B010100	B019999	RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R551	321-0756-01	B020000		RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R552	321-0631-00			RES.,FXD,FILM:12.5K OHM,1%,0.125W	91637	MFF1816G12501F
R554	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R560	311-1150-00			RES.,VAR,WW:10K OHM,5%	73138	7381-1-0
R562	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91-81-0
R563	321-0354-00			RES.,FXD,FILM:47.5K OHM,1%,0.125W	91637	MFF1816G47501F
R565	311-1518-00			RES.,VAR,NONWIR:10K OHM,20%,1W	01121	11M-324
	----- -----			(R565, FURNISHED AS A UNIT WITH S565)		
R566	321-0198-00			RES.,FXD,FILM:1.13K OHM,1%,0.125W	91637	MFF1816G11300F
R567	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R570	321-0364-00	B010100	B019999	RES.,FXD,FILM:60.4K OHM,1%,0.125W	91637	MFF1816G60401F
R570	321-0720-03	B020000		RES.,FXD,FILM:60K OHM,0.25%,0.125W	91637	MFF1816D60001C
R571	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R572	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R573	308-0291-00			RES.,FXD,WW:2K OHM,5%,3W	91637	CW2B-20000J
R574	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R575	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R576	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R577	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R578	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R579	301-0111-00			RES.,FXD,CMPSN:110 OHM,5%,0.50W	01121	EB1115
R581	321-0720-03			RES.,FXD,FILM:60K OHM,0.25%,0.125W	91637	MFF1816D60001C
R582	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R583	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R584	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R585	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R586	308-0764-00			RES.,FXD,WW:2.7 OHM,5%,2W	75042	BWF-2R700J
R592	316-0123-00			RES.,FXD,CMPSN:12K OHM,10%,0.25W	01121	CB1231
S30	260-1641-00			SWITCH,SLIDE:DPDT,0.5A,125VAC	10389	23-021-114
S120	263-1027-00			CAM SW ACTR AS:LOAD RESISTANC	80009	263-1027-00
S130	263-1026-00			SW CAM ACTR AS:SOURCE RESISTANCE	80009	263-1026-00
S140	105-0467-00			ACTUATOR,SWITCH:DUT SUPPLY ON,OFF	80009	105-0467-00
S200A,B	260-1310-00			SWITCH,PUSH:4PDT MOMENTARY	71590	2KAA0010000-437
S300	263-1025-00			SW CAM ACTR AS:FUNCTION	80009	263-1025-00
S350	263-1024-00			SW CAM ACTR AS:VERTICAL UNITS/DIV	80009	263-1024-00
S420	260-1529-00			SWITCH,ROTARY:	76854	5-18252-142
S441	260-0247-00			SWITCH,PUSH:SPST,1A,115VAC	81073	30YY1009

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
S460	311-1310-00			RES.,VAR,NONWIR:20K OHM,20%,1W	01121	10M654
	----- -----			(S460, FURNISHED AS A UNIT WITH R460)		
S565	311-1518-00			RES.,VAR,NONWIR:10K OHM,20%,1W	01121	11M-324
	----- -----			(S565, FURNISHED AS A UNIT WITH R565)		
U16	156-0067-00	B010100	B030709	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP
U16	156-0105-00	B030710		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM301AN
U250	156-0400-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
U340	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U350	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U424	156-0200-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1456P1
U432	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U460	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U476	156-0400-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
U540	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP
U576	156-0400-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
VR121	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	14552	TD3810983
VR238	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR239	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR268	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR269	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR281	152-0508-00			SEMICOND DEVICE:ZENER,0.4W,12.6V,5%	80009	152-0508-00
VR472	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR572	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

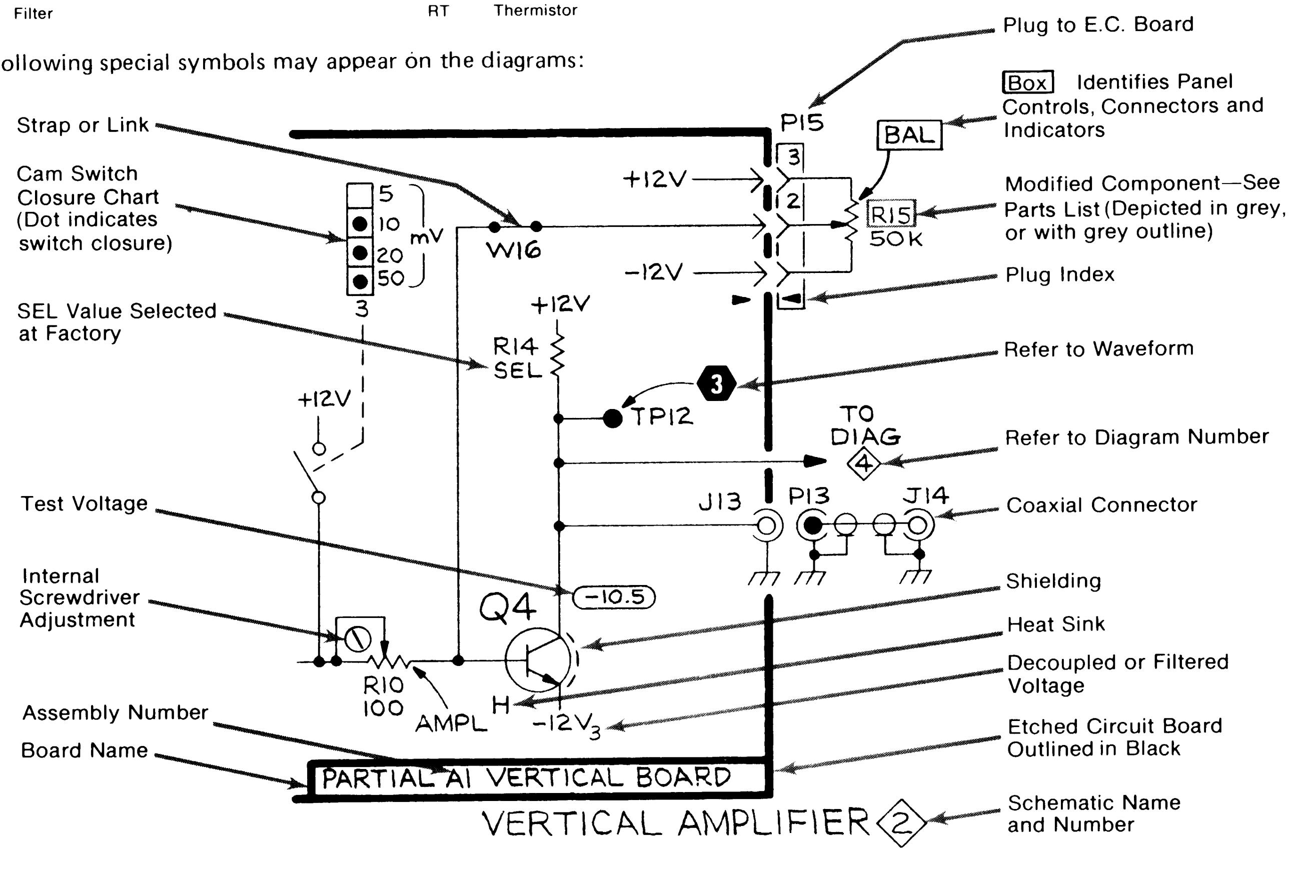
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc)
AT	Attenuator, fixed or variable
B	Motor
BT	Battery
C	Capacitor, fixed or variable
CB	Circuit breaker
CR	Diode, signal or rectifier
DL	Delay line
DS	Indicating device (lamp)
E	Spark Gap, Ferrite bead
F	Fuse
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc)
HR	Heater
HY	Hybrid circuit
J	Connector, stationary portion
K	Relay
L	Inductor, fixed or variable
M	Meter
P	Connector, movable portion
Q	Transistor or silicon-controlled rectifier
R	Resistor, fixed or variable
RT	Thermistor
S	Switch or contactor
T	Transformer
TC	Thermocouple
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
V	Electron tube
VR	Voltage regulator (zener diode, etc.)
W	Wirestrap or cable
Y	Crystal
Z	Phase shifter

The following special symbols may appear on the diagrams:


Plug to E.C. Board
Box Identifies Panel Controls, Connectors and Indicators
Strap or Link
Cam Switch Closure Chart (Dot indicates switch closure)
SEL Value Selected at Factory
Test Voltage
Internal Screwdriver Adjustment
Assembly Number
Board Name
Modified Component—See Parts List (Depicted in grey, or with grey outline)
Plug Index
Refer to Waveform
Refer to Diagram Number
Coaxial Connector
Shielding
Heat Sink
Decoupled or Filtered Voltage
Etched Circuit Board Outlined in Black
Schematic Name and Number
P15
BAL
3
2
+12V
-12V
R15
50K
5
10
20
50
mV
W16
3
+12V
R14
SEL
3
TP12
TO DIAG
4
+12V
J13
P13
J14
Q4
-10.5
R10
100
AMPL
H
-12V3
PARTIAL A1 VERTICAL BOARD
VERTICAL AMPLIFIER
2

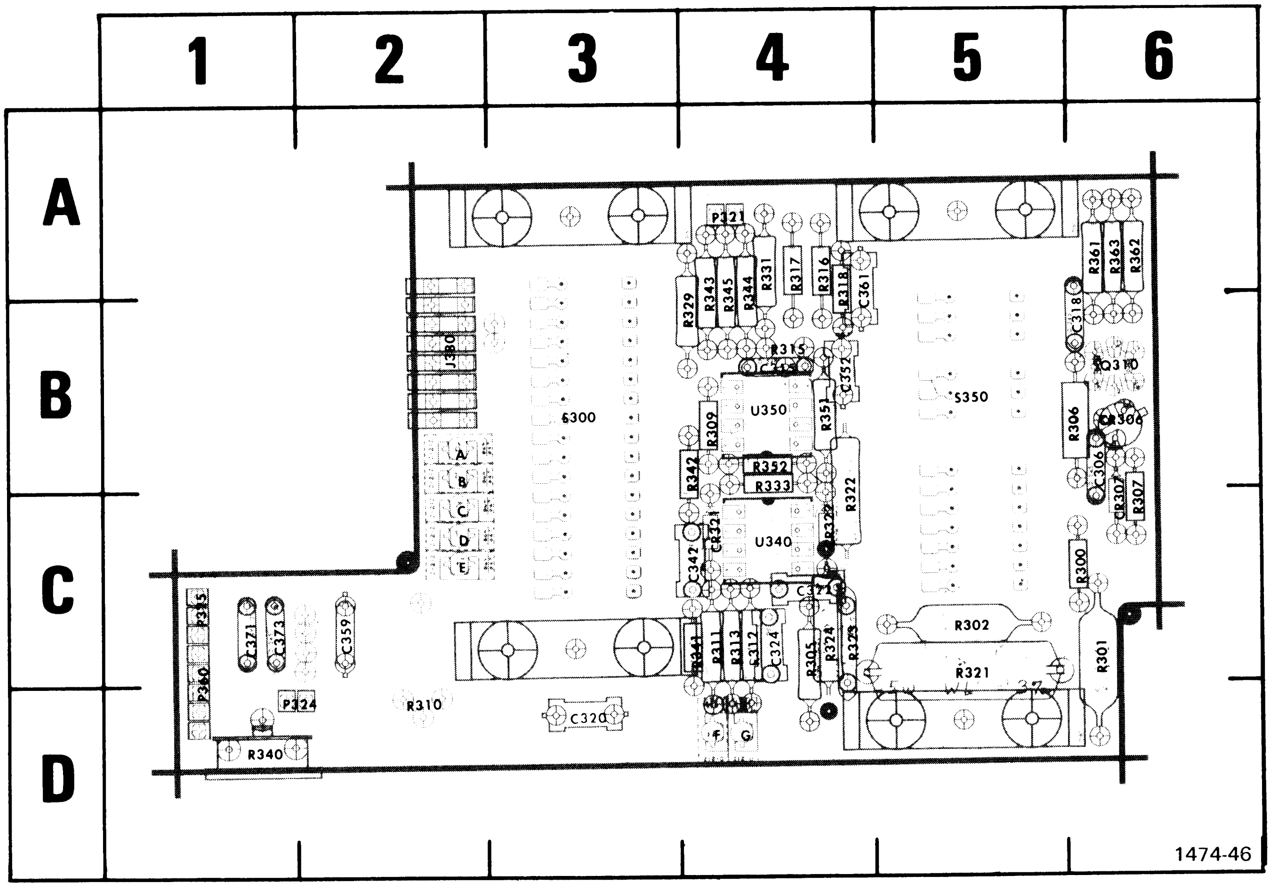
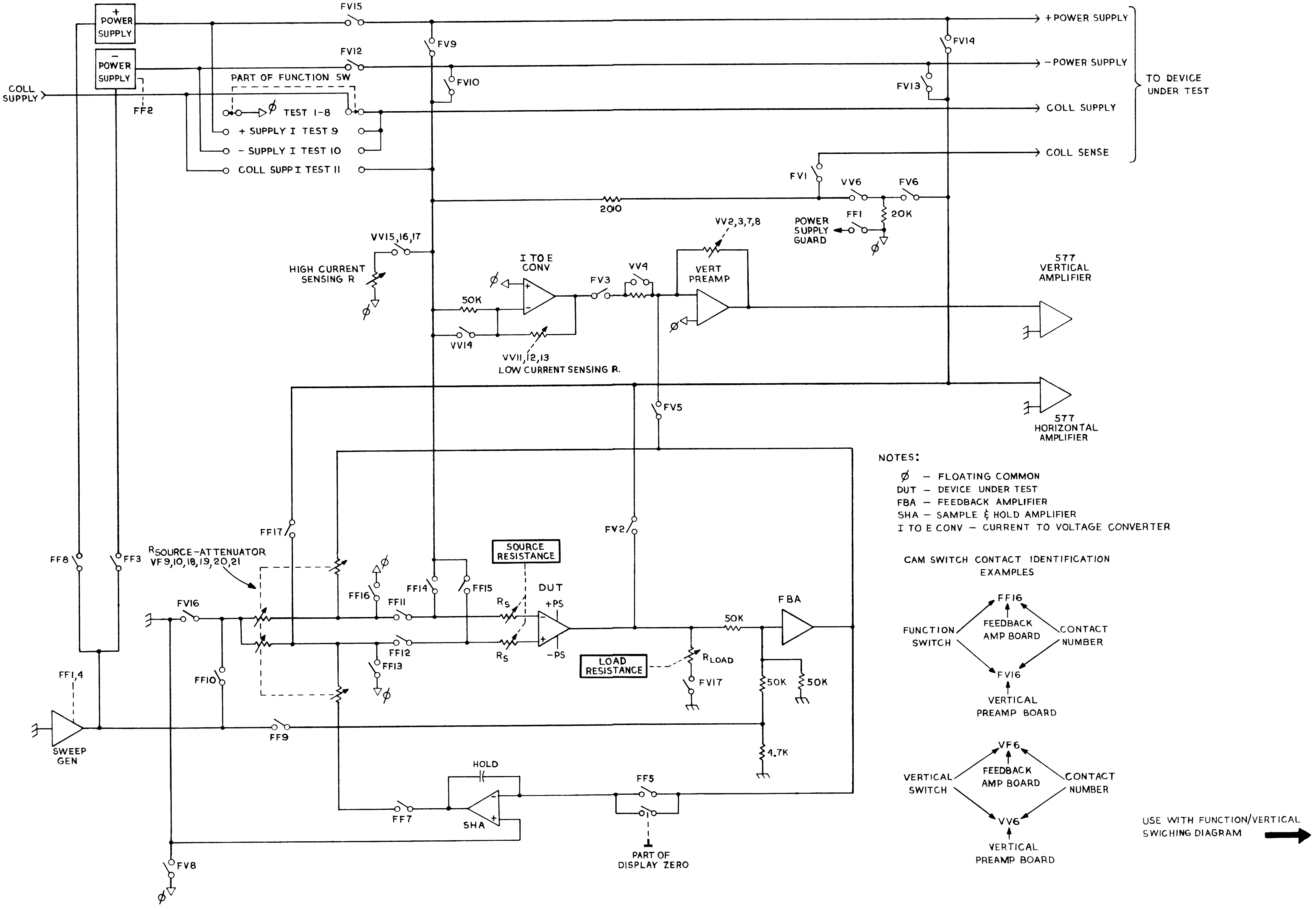

1
2
3
4
5
6
A
B
C
D
P321
R329
R343
R345
R344
R331
R317
R316
R318
C361
C318
R361
R363
R362
J380
S300
R315
C315
C352
S350
Q310
U350
R309
R351
R306
CR306
R342
R352
R333
R322
C306
CR307
R307
CR321
CR322
U340
C342
R300
C371
C373
C359
P325
P360
C322
R302
R341
R311
R313
R312
C324
R305
R324
R323
R321
R301
P324
R310
C320
R340
A
B
C
D
E
F
G
1474-46

Fig. 7-1. A2—Vertical Preamp circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C306	6B	CR306	6B	R300	6C	R317	4A	R344	4A
C315	4B	CR307	6C	R301	6C	R318	4A	R345	4A
C318	6B	CR321	4C	R302	5C	R321	5C	R351	4B
C322	4C	CR322	4C	R305	4C	R322	4C	R352	4B
C320	3D	J380	2B	R306	6B	R323	4C	R361	6A
C324	4C			R307	6C	R324	4C	R362	6A
C342	4C			R309	4B	R329	4B	R363	6A
C352	4B	P321	4A	R310	2D	R331	4A		
C359	2C	P324	1D	R311	4C	R333	4B	S300	3B
C361	4A	P325	1C	R312	4C	R340	1D	S350	5B
C371	1C	P360	1C	R313	4C	R341	4C		
C373	1C			R315	4B	R342	4B	U340	4C
		Q310	6B	R316	4A	R343	4A	U350	4B


+ POWER SUPPLY
– POWER SUPPLY
COLL SUPPLY
FF2
FV15
FV12
FV9
FV10
FV14
FV13
PART OF FUNCTION SW
TEST 1-8
+ SUPPLY I TEST 9
– SUPPLY I TEST 10
COLL SUPP I TEST 11
+POWER SUPPLY
–POWER SUPPLY
COLL SUPPLY
COLL SENSE
TO DEVICE UNDER TEST
FV1
VV6
FV6
2010
20K
POWER SUPPLY GUARD
FF1
VV2,3,7,8
VV15,16,17
HIGH CURRENT SENSING R
I TO E CONV
50K
VV14
VV11,12,13
LOW CURRENT SENSING R.
FV3
VV4
VERT PREAMP
577 VERTICAL AMPLIFIER
577 HORIZONTAL AMPLIFIER
FV5
FF17
FV2
FF8
FF3
RSOURCE-ATTENUATOR
VF9,10,18,19,20,21
SOURCE RESISTANCE
FF16
FF11
FF14
FF15
DUT
+PS
–PS
R_S
R_S
FV16
FF12
FF13
FF10
LOAD RESISTANCE
R_{LOAD}
FV17
50K
FBA
50K
50K
FF1,4
SWEEP GEN
FF9
4.7K
HOLD
SHA
FF7
FF5
PART OF DISPLAY ZERO
FV8
FF16
FUNCTION SWITCH
FEEDBACK AMP BOARD
CONTACT NUMBER
FV16
VERTICAL PREAMP BOARD
VF6
VERTICAL SWITCH
FEEDBACK AMP BOARD
CONTACT NUMBER
VV6
VERTICAL PREAMP BOARD

NOTES:

Ø – FLOATING COMMON
DUT – DEVICE UNDER TEST
FBA – FEEDBACK AMPLIFIER
SHA – SAMPLE & HOLD AMPLIFIER
I TO E CONV – CURRENT TO VOLTAGE CONVERTER

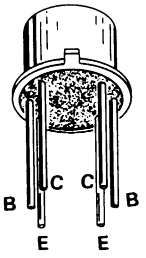
CAM SWITCH CONTACT IDENTIFICATION EXAMPLES

USE WITH FUNCTION/VERTICAL SWICHING DIAGRAM ➡

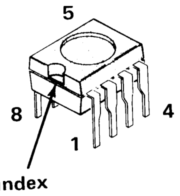
SWITCHING BLOCK DIAGRAM
(WITH STANDARD OP-AMP CARD)

1474-57
@

P.S 8-8-73



METAL-CASED TRANSISTORS



INTEGRATED CIRCUITS

1

VOLTAGE AND WAVEFORM CONDITIONS

The waveforms shown were obtained with the controls initially set as follows:

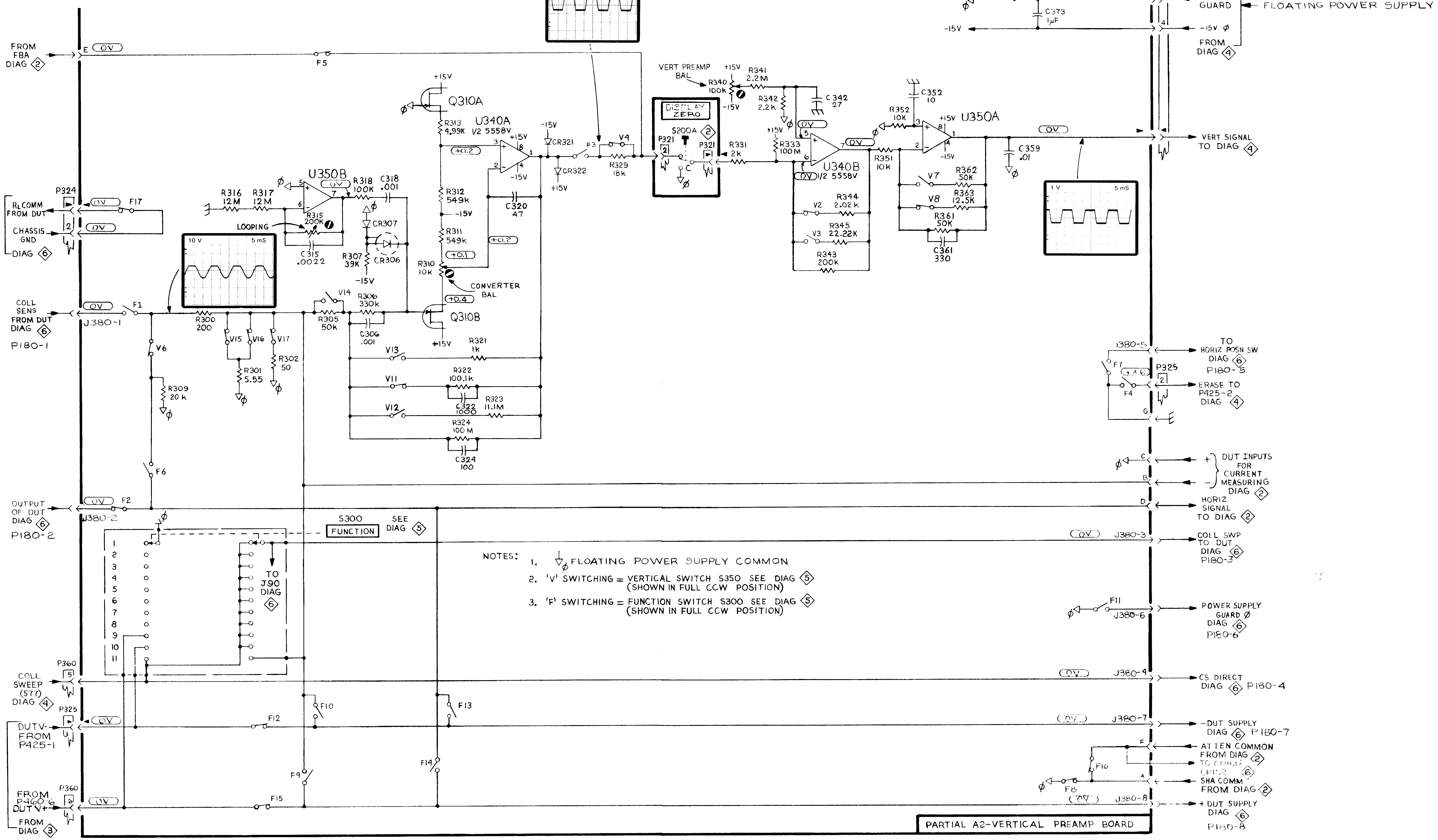
577

Variable Collecter %	0
Max Peak Volts	6.5
Max Peak Power Watts	.15
Intensity	ccw
All other controls	any position

178

DUT SUPPLIES	ON
LOAD RESISTANCE	ccw
SOURCE RESISTANCE	ccw
+SUPPLY	0.0
SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	set for 6 volts peak-to-peak at TP448
SWEEP FREQUENCY	100 Hz
Vernier	midrange
FUNCTION	INPUT I
VERT UNITS/DIV	2 mV

VOLTAGE & WAVEFORM CONDITIONS


FROM FBA DIAG ②
E 0V
F5
1 V 5 mS
VERT PREAMP BAL
R340 100k
+15V
-15V
R341 2.2M
R342 2.2k
C342 27
DISPLAY ZERO
S200A ②
P321
R331 2k
+15V
R333 100M
U340B 1/2 5558V
R344 2.02k
R345 22.22K
R343 200k
V2
V3
C352 10
R352 10k
U350A
+15V
-15V
R351 10k
C359 .01
R362 50K
R363 12.5K
R361 50K
C361 330
V7
V8
0V
VERT SIGNAL TO DIAG ④
P360
+15V
+15V ⏚
C371 1µF
C373 1µF
PS GUARD
FLOATING POWER SUPPLY
-15V
-15V ⏚
FROM DIAG ④
Q310A
R313 4.99K
U340A 1/2 5558V
+0.2
R312 549k
-15V
R311 549k
+0.1
+0.2
R310 10k
CONVERTER BAL
+0.4
Q310B
C320 47
CR321
CR322
F3
V4
R329 18k
U350B
0V
R318 100K
C318 .001
R316 12M
R317 12M
R315 200K
LOOPING
C315 .0022
CR307
CR306
R307 39K
P324
RL COMM FROM DUT
CHASSIS GND
DIAG ⑥
F17
10 V 5 mS
COLL SENS FROM DUT DIAG ⑥
J380-1
P180-1
F1
R300 200
V14
R306 330k
R305 50k
C306 .001
V15
V16
V17
R301 5.55
R302 50
V6
R309 20k
F6
V13
R321 1k
V11
R322 100.1k
C322 1000
R323 11.1M
V12
R324 100 M
C324 100
OUTPUT OF DUT DIAG ⑥
P180-2
J380-2
F2
S300 FUNCTION
SEE DIAG ⑤
1
2
3
4
5
6
7
8
9
10
11
TO J90 DIAG ⑥
J380-5
TO HORIZ POSN SW DIAG ⑥
P180-5
F7
F4
P325
ERASE TO P425-2 DIAG ④
G
C
B
D
DUT INPUTS FOR CURRENT MEASURING DIAG ②
HORIZ SIGNAL TO DIAG ②
J380-3
COLL SWP TO DUT DIAG ⑥ P180-3
F11
J380-6
POWER SUPPLY GUARD ⏚ DIAG ⑥ P180-6
P360
COLL SWEEP (577) DIAG ④
J380-4
CS DIRECT DIAG ⑥ P180-4
F10
F13
P325
DUTV- FROM P425-1
F12
J380-7
-DUT SUPPLY DIAG ⑥ P180-7
F
ATTEN COMMON FROM DIAG ②
TO CR1512 CR1522 ⑥
F16
A
SHA COMM FROM DIAG ②
F8
F9
F14
F15
FROM P460-6 DUTV+
FROM DIAG ③
J380-8
+DUT SUPPLY DIAG ⑥ P180-8
PARTIAL A2-VERTICAL PREAMP BOARD

NOTES:
1. ⏚ FLOATING POWER SUPPLY COMMON
2. 'V' SWITCHING = VERTICAL SWITCH S350 SEE DIAG ⑤ (SHOWN IN FULL CCW POSITION)
3. 'F' SWITCHING = FUNCTION SWITCH S300 SEE DIAG ⑤ (SHOWN IN FULL CCW POSITION)

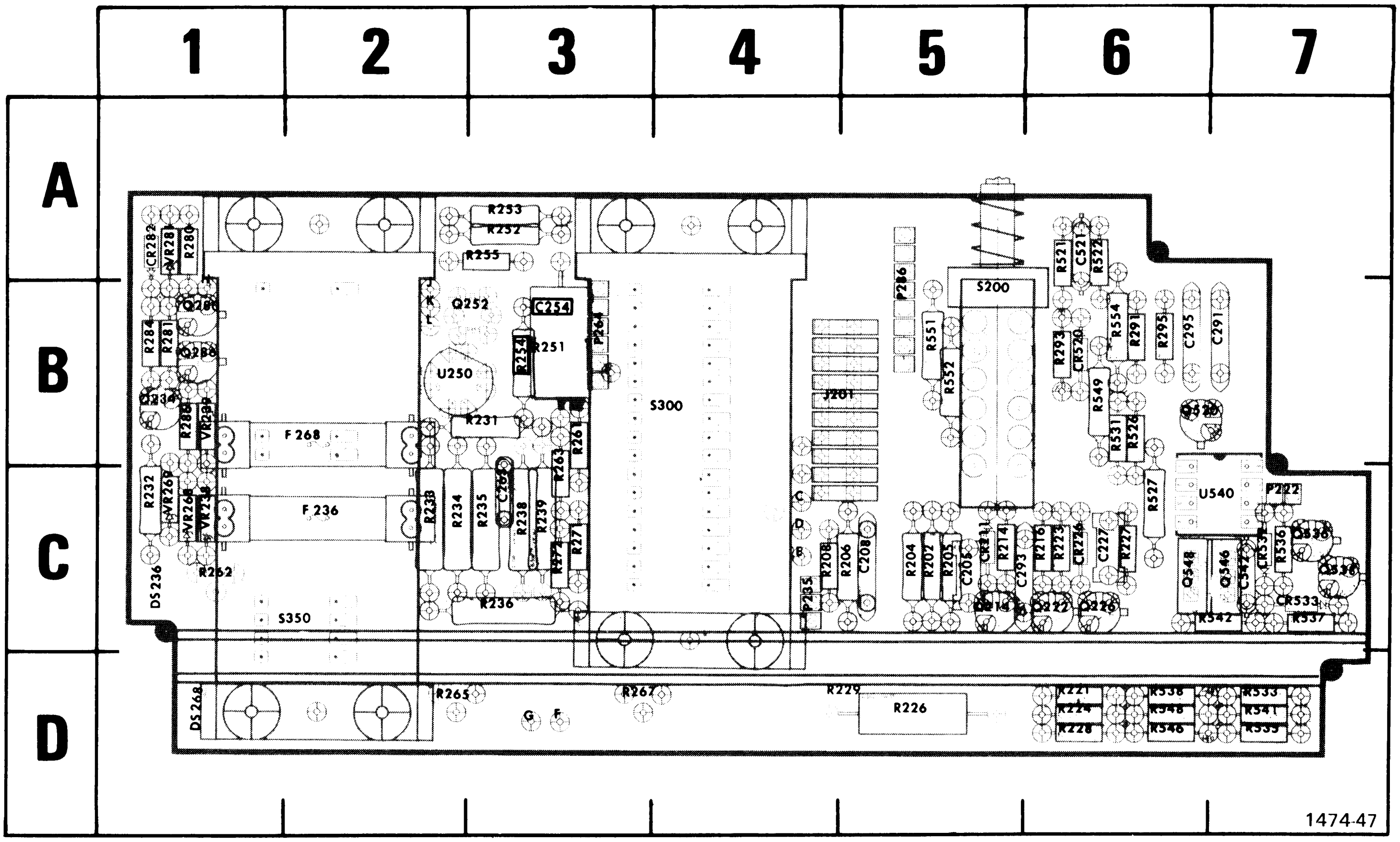
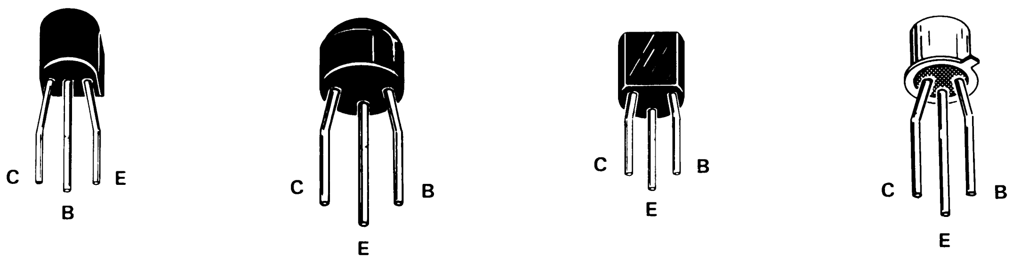
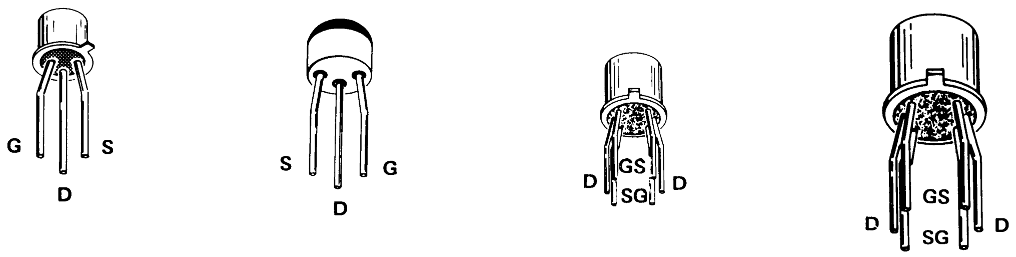

1
2
3
4
5
6
7
A
B
C
D
CR282
VR281
R280
Q280
R284
R281
Q286
Q284
R286
VR239
R232
VR269
VR268
VR238
R262
DS236
S350
DS268
F 268
F 236
R253
R252
R255
Q252
C254
R254
R251
P264
U250
R231
R261
R263
R233
R234
R235
C263
R238
R239
R272
R271
R236
R265
G
F
R267
S300
P286
J201
R551
R552
S200
R229
R226
C
D
B
R208
R206
C208
P235
R204
R202
R205
C205
CR211
R214
C293
R216
R223
CR226
C227
R227
Q214
Q222
Q226
R521
C521
R522
R293
CR520
R554
R291
R295
C295
C291
R549
R531
R526
Q520
R527
U540
P222
Q548
Q546
C542
CR532
R535
R536
Q536
Q538
CR533
R542
R537
R221
R224
R228
R538
R548
R546
R533
R541
R535
1474-47

Fig. 7-2. A3—Feedback Amplifier circuit board.

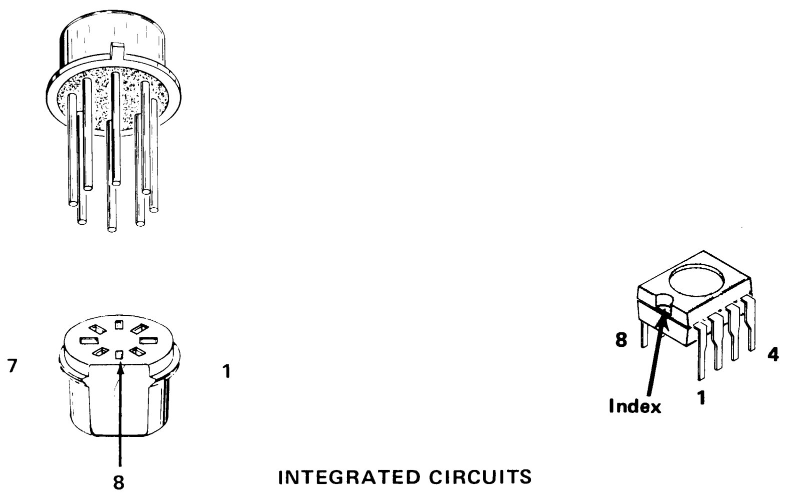
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C205	5C	DS236	1C	Q280	1B	R223	6C	R254	3B	R522	6A	R554	6B
C208	5C	DS268	1D	Q284	1B	R224	6D	R255	3A	R525	5B		
C227	6C			Q286	1B	R226	5D	R261	3B	R526	6B	S200	5B
C254	3B	F236	2C	Q520	6B	R227	6C	R262	1C	R527	6C	S300	4B
C263	3C	F268	2B	Q536	7C	R228	6D	R263	3B	R531	6B	S350	2C
C291	7B			Q538	7C	R229	5D	R265	2D	R533	7D		
C293	5C	J201	5B	Q546	7C	R231	3B	R267	3D	R535	7D	U250	2B
C295	6B			Q548	6C	R232	1C	R271	3C	R536	7C	U540	7C
C521	6A	P222	7C			R233	2C	R272	3C	R537	7C		
C542	7C	P235	4C	R202	5C	R234	2C	R280	1A	R538	6D	VR238	1C
		P264	3B	R204	5C	R235	3C	R281	1B	R541	7D	VR239	1B
CR211	5C	P286	5B	R205	5C	R236	3C	R284	1B	R542	7C	VR268	1C
CR226	6C			R206	5C	R238	3C	R286	1B	R546	6D	VR269	1C
CR250	6B	Q214	5C	R208	4C	R239	3C	R291	6B	R548	6D	VR281	1A
CR282	1A	Q222	6C	R214	5C	R251	3B	R293	6B	R549	6B		
CR532	7C	Q226	6C	R216	6C	R252	3A	R295	6B	R551	5B		
CR533	7C	Q252	3B	R221	6D	R253	3A	R521	6A	R552	5B		


C
B
E
C
E
B
C
E
B
C
E
B

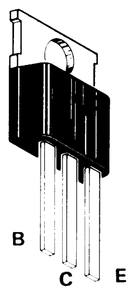
TRANSISTORS


G
D
S
S
D
G
D
GS
SG
D
D
GS
SG
D

FIELD EFFECT TRANSISTORS


7
1
8
8
Index
1
4

INTEGRATED CIRCUITS



POWER TRANSISTORS

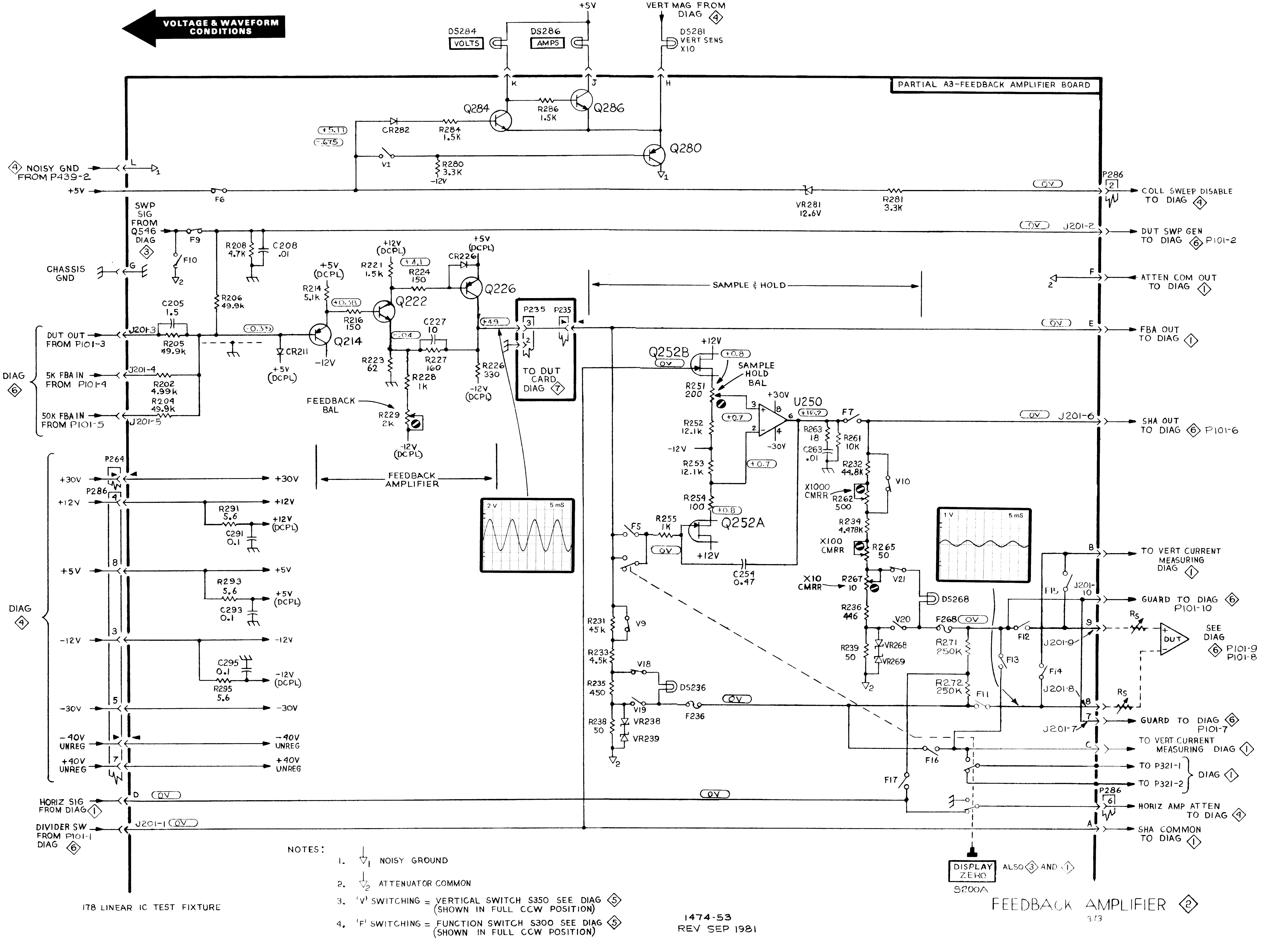
2

VOLTAGE AND WAVEFORM CONDITIONS

The waveforms shown were obtained with the controls initially set as follows:

577	
Variable Collector %	0
Max Peak Volts	6.5
Max Peak Power Watts	.15
Intensity	ccw
All other controls	any position

178	
DUT SUPPLIES	ON
LOAD RESISTANCE	ccw
SOURCE RESISTANCE	ccw
+SUPPLY	0.0
−SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	set for 6 volts peak-to-peak at TP488
SWEEP FREQUENCY	100 Hz
Vernier	midrange
FUNCTION	OFFSET V
VERT UNITS/DIV	2 mV


VOLTAGE & WAVEFORM CONDITIONS
PARTIAL A3-FEEDBACK AMPLIFIER BOARD
+5V
VERT MAG FROM DIAG ④
DS284 VOLTS
DS286 AMPS
DS281 VERT SENS X10
Q284
R286 1.5K
Q286
CR282
R284 1.5K
Q280
+5.11
-.675
V1
R280 3.3K
-12V
④ NOISY GND FROM P439-2
+5V
F6
VR281 12.6V
R281 3.3K
0V
P286
COLL SWEEP DISABLE TO DIAG ④
SWP SIG FROM Q546 DIAG ③
F9
F10
R208 4.7K
C208 .01
J201-2
DUT SWP GEN TO DIAG ⑥ P101-2
CHASSIS GND
+12V (DCPL)
R221 1.5k
+4.1
R224 150
+5V (DCPL)
CR226
Q226
+5V (DCPL)
R214 5.1k
+0.58
Q222
R216 150
Q214
-12V
ATTEN COM OUT TO DIAG ①
SAMPLE & HOLD
R206 49.9k
C205 1.5
DUT OUT FROM P101-3
J201-3
R205 49.9k
0.34
CR211
+5V (DCPL)
C227 10
-.04
R223 62
R227 160
R228 1K
R226 330
-12V (DCPL)
+4.9
P235
TO DUT CARD DIAG ⑦
FBA OUT TO DIAG ①
DIAG ⑥
5K FBA IN FROM P101-4
J201-4
R202 4.99k
R204 49.9k
50K FBA IN FROM P101-5
J201-5
FEEDBACK BAL
R229 2K
-12V (DCPL)
Q252B
+12V
+0.8
SAMPLE HOLD BAL
R251 200
+30V
U250
+16.2
F7
+0.7
R252 12.1k
-30V
R263 18
R261 10K
C263 .01
SHA OUT TO DIAG ⑥ P101-6
J201-6
-12V
R253 12.1k
+0.7
R232 44.8K
V10
X1000 CMRR
R262 500
FEEDBACK AMPLIFIER
P264
+30V
P286
+12V
R291 5.6
+12V (DCPL)
C291 0.1
2 V 5 mS
R254 100
+0.8
Q252A
F5
R255 1K
0V
+12V
C254 0.47
R234 4.478K
X100 CMRR
R265 50
1 V 5 mS
X10 CMRR
R267 10
V21
DS268
R236 446
TO VERT CURRENT MEASURING DIAG ①
GUARD TO DIAG ⑥ P101-10
F15
J201-10
DIAG ④
+5V
R293 5.6
+5V (DCPL)
C293 0.1
-12V
C295 0.1
R295 5.6
-12V (DCPL)
-30V
-40V UNREG
+40V UNREG
R231 45k
V9
R233 4.5k
V18
DS236
R235 450
V19
F236
R238 50
VR238
VR239
V20
F268
R271 250K
F12
J201-9
Rs
DUT
SEE DIAG ⑥ P101-9 P101-8
R239 50
VR268
VR269
F13
F14
R272 250K
F11
J201-8
GUARD TO DIAG ⑥ P101-7
J201-7
TO VERT CURRENT MEASURING DIAG ①
F16
TO P321-1
TO P321-2
DIAG ①
F17
HORIZ SIG FROM DIAG ①
HORIZ AMP ATTEN TO DIAG ④
DIVIDER SW FROM P101-1 DIAG ⑥
J201-1
SHA COMMON TO DIAG ①
DISPLAY ZERO S200A
ALSO ③ AND ①
A B C D E F G H J K L

NOTES:

1. NOISY GROUND
2. ATTENUATOR COMMON
3. 'V' SWITCHING = VERTICAL SWITCH S350 SEE DIAG ⑤ (SHOWN IN FULL CCW POSITION)
4. 'F' SWITCHING = FUNCTION SWITCH S300 SEE DIAG ⑤ (SHOWN IN FULL CCW POSITION)

178 LINEAR IC TEST FIXTURE

1474-53
REV SEP 1981

FEEDBACK AMPLIFIER ②

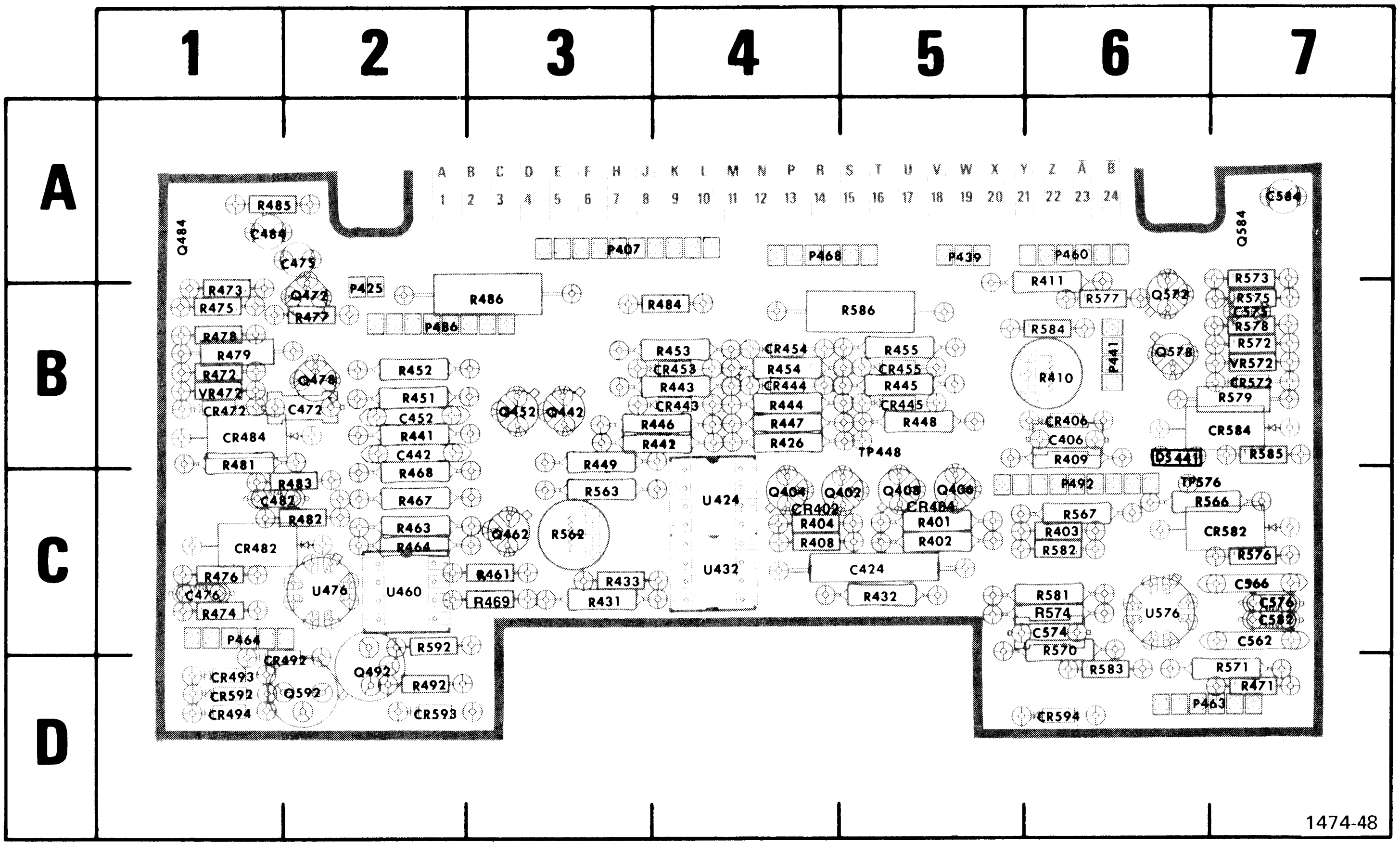
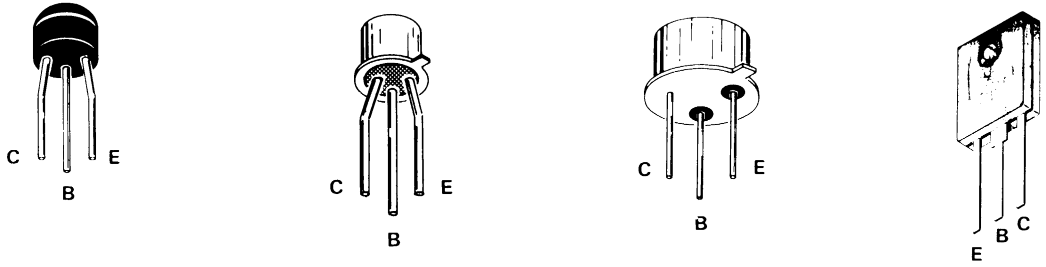

1
2
3
4
5
6
7
A
B
C
D
A B C D E F H J K L M N P R S T U V W X Y Z Ā B̄
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Q484
R485
C484
C475
C584
Q584
P407
P468
P439
P460
R473
R475
Q472
R477
P425
R486
P486
R484
R586
R411
R577
Q572
R573
R575
C575
R578
R572
VR572
CR572
R478
R479
R472
VR472
CR472
Q478
C472
R452
R451
C452
R441
C442
R468
R467
R463
R464
Q452
Q442
R453
CR453
R443
CR443
R446
R442
R449
R563
R562
Q462
R454
CR454
CR444
R454
R444
R447
R426
R455
CR455
R445
CR445
R448
TP448
R584
P441
R410
Q578
R579
CR584
CR406
C406
R409
DS441
R585
TP576
R566
CR484
R481
R483
C482
R482
CR482
U424
U432
Q404
CR402
Q402
Q408
Q406
CR404
R404
R408
R401
R402
P492
R567
R403
R582
CR582
R576
R476
C476
R474
U476
U460
R461
R469
R433
R431
C424
R432
R581
R574
C574
R570
U576
C566
C576
C582
C562
P464
CR492
CR493
CR592
CR494
Q592
Q492
R592
R492
CR593
R583
R571
R471
P463
CR594
1474-48

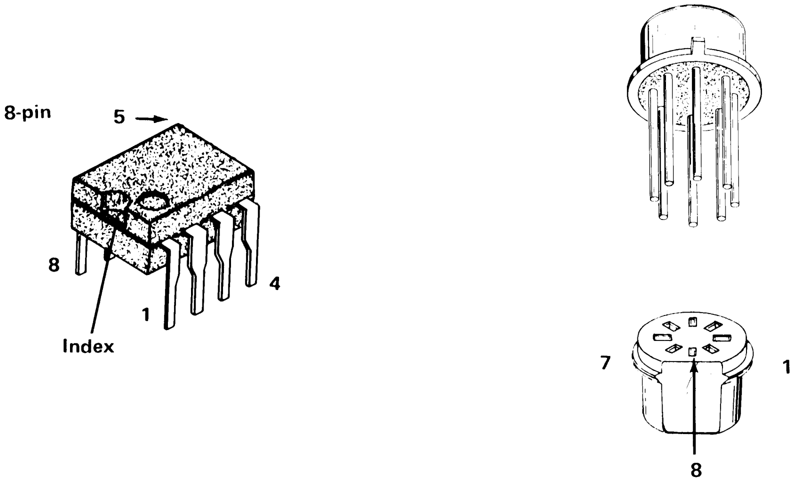
Fig. 7-3. A4—Power Supply circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C406	6B	CR453	4B	P463	6D	R401	5C	R452	2B	R484	4B	R585	7B
C424	5C	CR454	4B	P464	1C	R402	5C	R453	4B	R485	1A	R586	5B
C442	2B	CR455	5B	P468	4A	R403	6C	R454	4B	R486	3B	R592	2C
C452	2B	CR472	1B	P486	2B	R404	4C	R455	5B	R492	2D		
C472	2B	CR482	1C	P492	6C	R408	4C	R461	3C	R562	3C	TP448	5B
C475	2A	CR484	1B			R409	6B	R463	2C	R563	3C	TP576	6C
C476	1C	CR492	2D	Q402	5C	R410	6B	R464	2C	R566	7C		
C482	1C	CR493	1D	Q404	4C	R411	6A	R467	2C	R567	6C	U424	4C
C484	1A	CR494	1D	Q406	5C	R426	4B	R468	2C	R570	6C	U432	4C
C562	7C	CR572	7B	Q408	5C	R431	3C	R469	3C	R571	7D	U460	2C
C566	7C	CR582	7C	Q442	3B	R432	5C	R471	7D	R572	7B	U476	2C
C574	6C	CR584	7B	Q452	3B	R433	3C	R472	1B	R573	7A	U576	6C
C575	7B	CR593	2D	Q462	3C	R441	2B	R473	1B	R574	6C		
C576	7C	CR592	1D	Q472	2B	R442	4B	R474	1C	R575	7B	VR472	1B
C582	7C	CR594	6D	Q478	2B	R443	4B	R475	1B	R576	7C	VR572	7B
C584	7A			Q484	1A	R444	4B	R476	1C	R577	6B		
CR404	5C	DS441	6B	Q492	2D	R445	5B	R477	2B	R578	7B		
CR402	4C	P407	3A	Q572	6B	R446	4B	R478	1B	R579	7B		
CR406	6B	P425	2B	Q578	6B	R447	4B	R479	1B	R581	6C		
CR443	4B	P439	5A	Q584	7A	R448	5B	R481	1B	R582	6C		
CR444	4B	P441	6B	Q592	2D	R449	3B	R482	2C	R583	6D		
CR445	5B	P460	6A			R451	2B	R483	2C	R584	6B		

ASSEMBLY A4


C
B
E
C
B
E
C
B
E
E
B
C

TRANSISTORS


8-pin
5
8
1
4
Index
7
1
8

INTEGRATED CIRCUITS

3

VOLTAGE AND WAVEFORM CONDITIONS

The waveforms shown were obtained with the controls initially set as follows:

577

Variable Collector %	0
Max Peak Volts	6.5
Max Peak Power Watts	.15
Intensity	ccw
All other controls	any position

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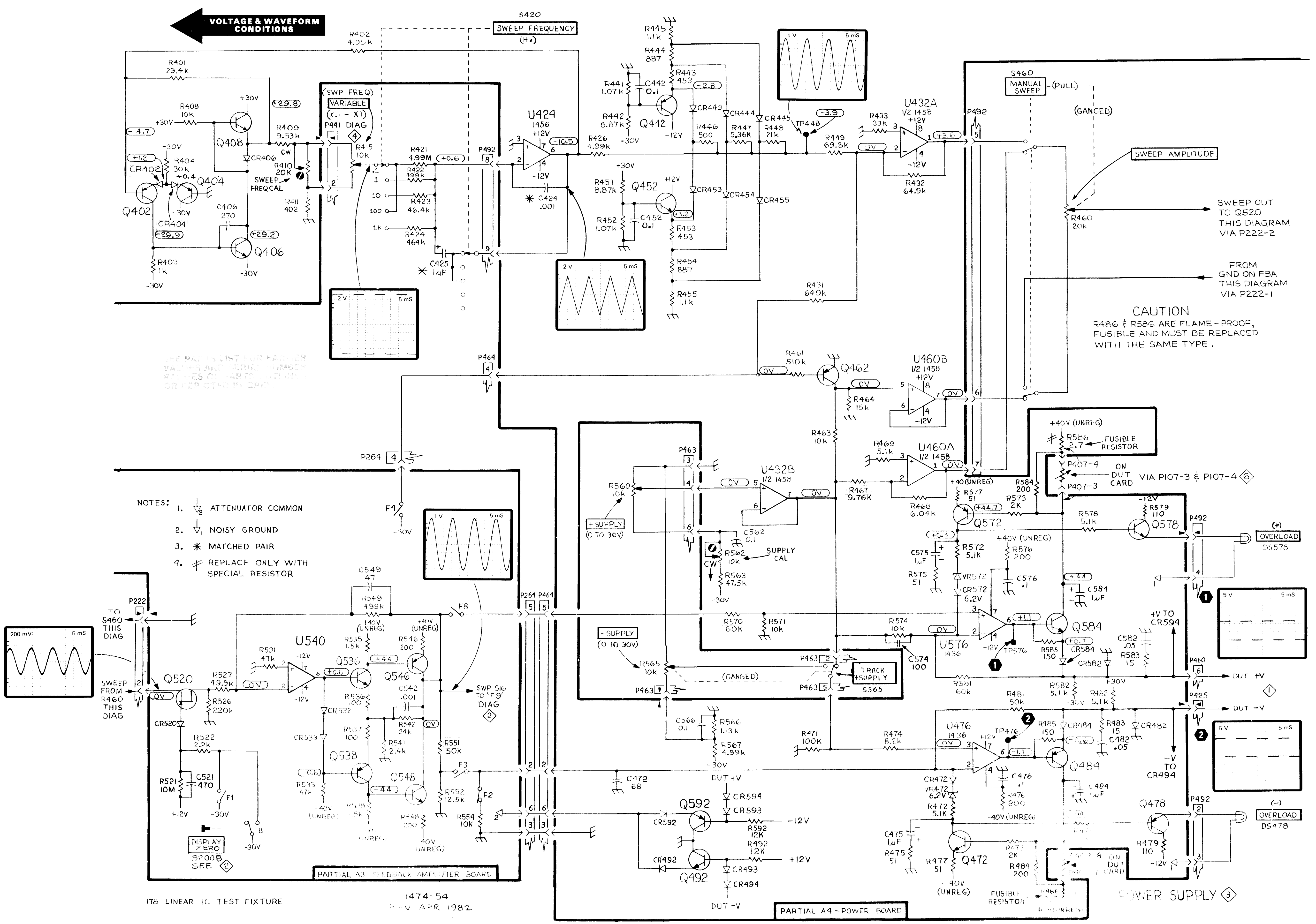
DUT SUPPLIES	ON
LOAD RESISTANCE	ccw
SOURCE RESISTANCE	ccw
+SUPPLY	0.0
−SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	set for 6 volts peak-to-peak at TP448
SWEEP FREQUENCY	100 Hz
Vernier	midrange
VERT UNITS/DIV	2 mV

VOLTAGE & WAVEFORM CONDITIONS


S420
SWEEP FREQUENCY (Hz)
R402 4.95k
R401 29.4k
R408 10k
+30V
Q408
+29.8
-4.7
R409 9.53k
CW
R410 20K
SWEEP FREQ CAL
R411 402
CR406
R404 30k
+0.4
Q404
+1.2
CR402
Q402
CR404
-30V
C406 270
-29.9
+29.2
Q406
R403 1k
(SWP FREQ)
VARIABLE
(X.1 - X1)
P441 DIAG ④
R415 10k
R421 4.99M
+0.6
R422 499k
R423 46.4k
R424 464k
.1 1 10 100 1k
C425 1µF
U424 1456
+12V
-12V
-10.5
C424 .001
P492
R426 4.99k
R445 1.1k
R444 887
R443 453
-2.8
R441 1.07k
C442 0.1
R442 8.87k
Q442
CR443
CR444
CR445
R446 500
R447 5.36K
R448 21k
TP448
-3.9
R449 69.8k
R451 8.87k
Q452
R452 1.07k
C452 0.1
+3.2
CR453
CR454
CR455
R453 453
R454 887
R455 1.1k
R431 649k
1 V 5 mS
2 V 5 mS
U432A 1/2 1458
R433 33k
+3.6
0V
R432 64.9k
S460
MANUAL SWEEP
(PULL)
(GANGED)
SWEEP AMPLITUDE
R460 20k
SWEEP OUT TO Q520 THIS DIAGRAM VIA P222-2
FROM GND ON FBA THIS DIAGRAM VIA P222-1
P464
R461 510k
Q462
U460B 1/2 1458
R464 15k
R463 10k
U460A 1/2 1458
R469 5.1k
R467 9.76K
R468 6.04k
P264
F4
P463
U432B 1/2 1458
R560 10k
+ SUPPLY (0 TO 30V)
C562 0.1
R562 10k
SUPPLY CAL
R563 47.5k
- SUPPLY (0 TO 30V)
R565 10k
(GANGED)
TRACK +SUPPLY
S565
C566 0.1
R566 1.13k
R567 4.99k
+40V (UNREG)
R586 2.7
FUSIBLE RESISTOR
P407-4
P407-3
ON DUT CARD
VIA P107-3 & P107-4 ⑥
R584 200
R577 51
+44.7
R573 2K
Q572
R578 5.1k
R579 110
Q578
(+) OVERLOAD DS578
R572 5.1K
C575 1µF
R575 51
VR572
CR572 6.2V
R576 200
C576 .1
+44
C584 1µF
U576 1436
TP576
+1.1
+0.7
Q584
R585 150
CR584
CR582
R583 15
C582 .05
+V TO CR594
P460
DUT +V
① ②
P425
DUT -V
R570 60K
R571 10k
R574 10k
C574 100
R581 60k
R481 50k
R582 5.1k
R482 5.1k
R471 100K
R474 8.2k
U476 1436
TP476
R485 150
CR484
R483 15
C482 .05
CR482
Q484
-V TO CR494
C476 .1
R476 200
C484 1µF
CR472
VR472 6.2V
R472 5.1K
-40V (UNREG)
C475 1µF
R475 51
R477 51
Q472
R473 2K
R484 200
FUSIBLE RESISTOR
Q478
R479 110
(-) OVERLOAD DS478
5 V 5 mS
C472 68
DUT +V
CR594
CR593
Q592
CR592
R592 12K
-12V
R492 12K
+12V
CR492
Q492
CR493
CR494
DUT -V
PARTIAL A4 - POWER BOARD
POWER SUPPLY ③
P222
TO S460 THIS DIAG
SWEEP FROM R460 THIS DIAG
200 mV 5 mS
Q520
CR520
R527 49.9k
R526 220k
R522 2.2k
R521 10M
C521 470
F1
DISPLAY ZERO
S200B SEE ②
U540
R531 47k
R535 1.5k
140V (UNREG)
Q536
+44
R546 200
Q546
C549 47
R549 499k
F8
C542 .001
R542 24k
R536 100
CR532
CR533
R537 100
R541 2.4k
Q538
-0.6
-44
Q548
R533 47k
R548 200
R551 50K
F3
F2
R552 12.5k
R554 10K
SWP SIG TO 'F9' DIAG ②
PARTIAL A3 FEEDBACK AMPLIFIER BOARD

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

CAUTION
R486 & R586 ARE FLAME-PROOF, FUSIBLE AND MUST BE REPLACED WITH THE SAME TYPE.

NOTES:
1. ATTENUATOR COMMON
2. NOISY GROUND
3. ✱ MATCHED PAIR
4. REPLACE ONLY WITH SPECIAL RESISTOR

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REV APR 1982

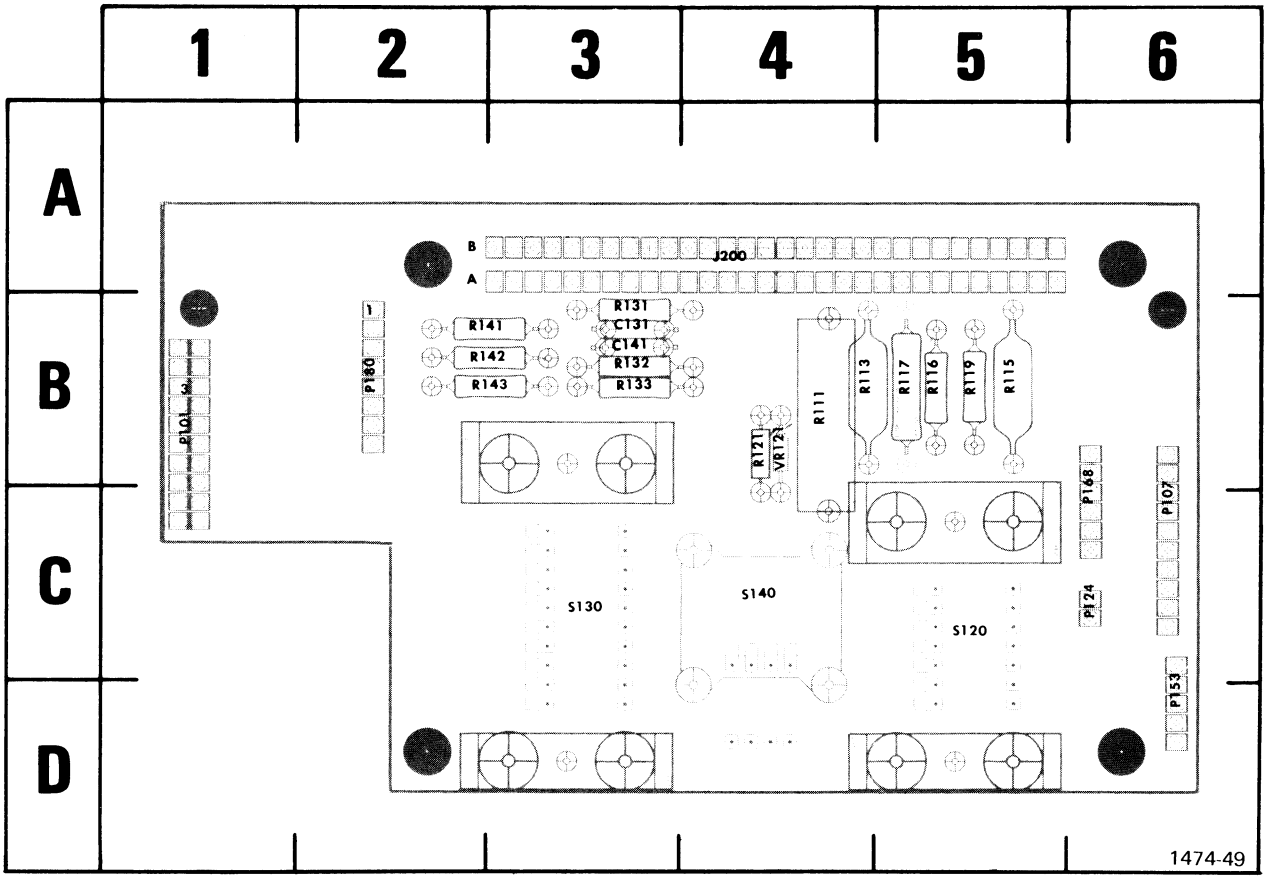
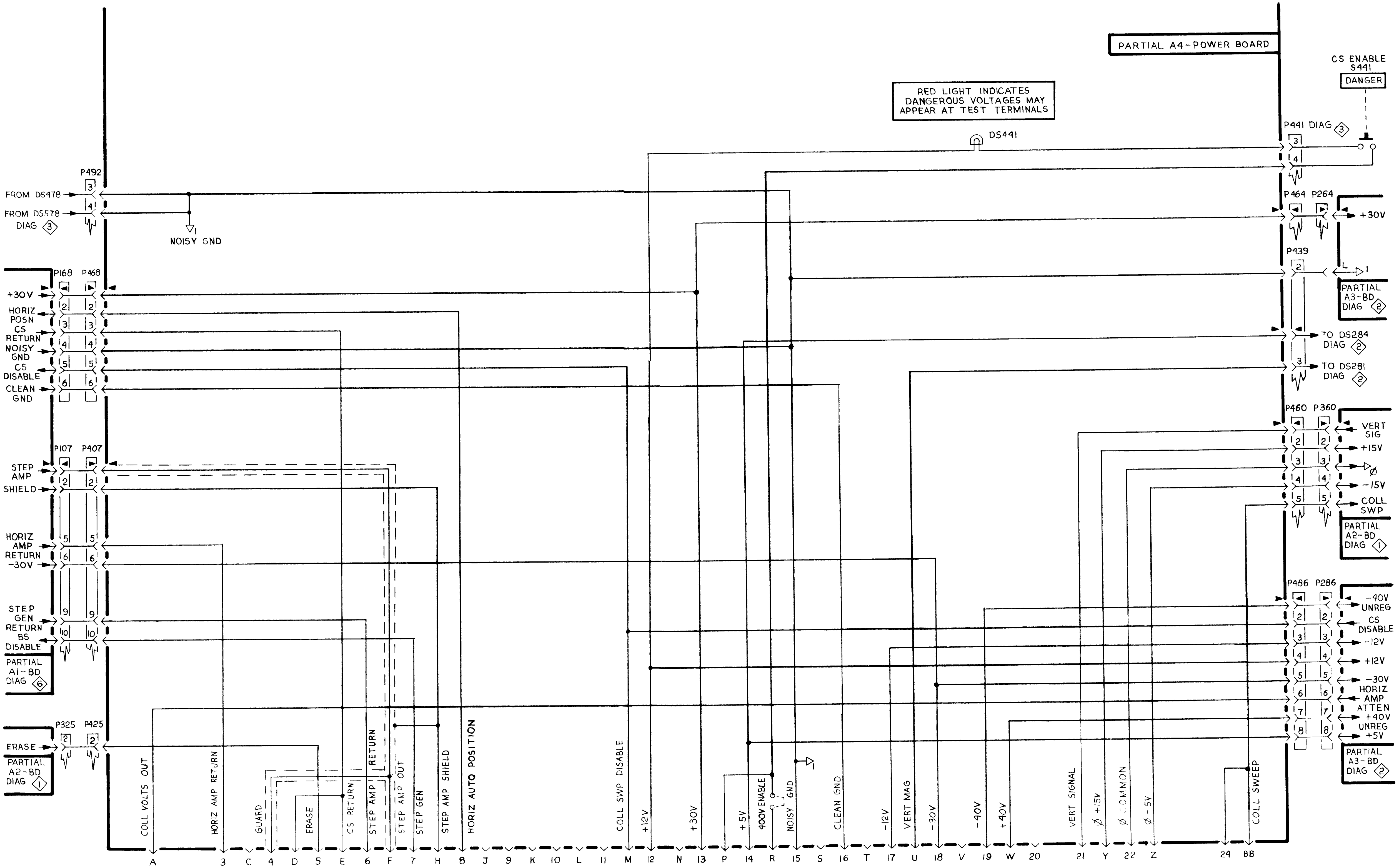

1
2
3
4
5
6
A
B
C
D
J200
B
A
1
P180
P101
R141
R142
R143
R131
C131
C141
R132
R133
R121
VR121
R111
R113
R117
R116
R119
R115
P168
P107
P124
P153
S130
S140
S120
1474-49

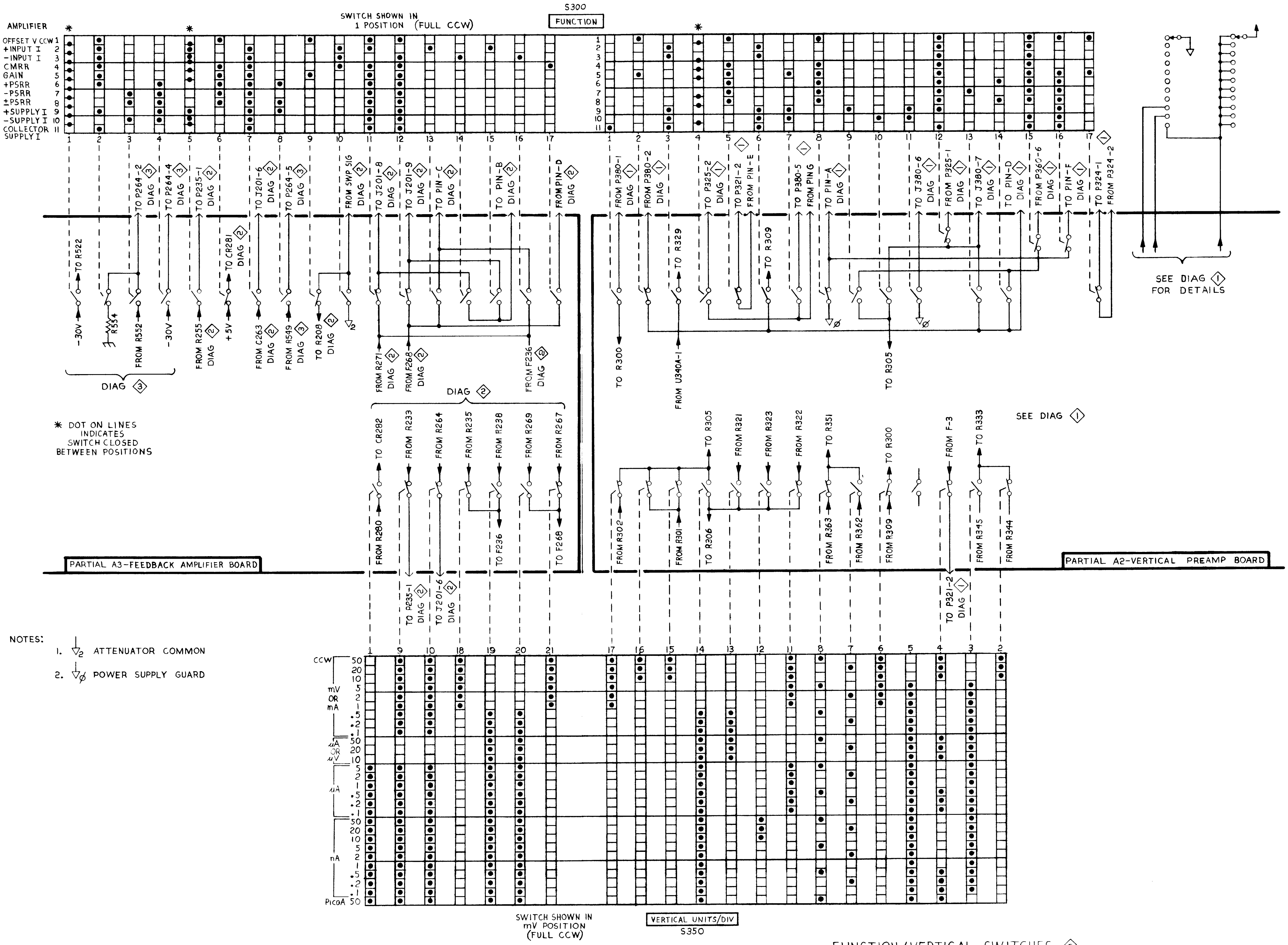
Fig. 7-4. A1—Interface circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC
C131	3B	R115	5B
C141	3B	R119	5B
		R121	4B
J200	4A	R131	3B
		R132	3B
P101	1B	R133	3B
P107	6C	R141	2B
P124	6C	R142	2B
P153	6D	R143	2B
P168	6C		
P180	2B	S120	5C
		S130	3C
R111	4B	S140	4C
R113	4B		
R116	5B	VR121	4B
R117	5B		


PARTIAL A4-POWER BOARD
CS ENABLE S441
DANGER
RED LIGHT INDICATES DANGEROUS VOLTAGES MAY APPEAR AT TEST TERMINALS
DS441
P441 DIAG ③
P492
FROM DS478
FROM DS578
DIAG ③
NOISY GND
P464 P264
+30V
P439
PARTIAL A3-BD DIAG ②
TO DS284 DIAG ②
TO DS281 DIAG ②
P168 P468
+30V
HORIZ POSN
CS RETURN
NOISY GND
CS DISABLE
CLEAN GND
P107 P407
STEP AMP
SHIELD
HORIZ AMP
RETURN
-30V
STEP GEN
RETURN
BS DISABLE
PARTIAL A1-BD DIAG ⑥
P325 P425
ERASE
PARTIAL A2-BD DIAG ①
P460 P360
VERT SIG
+15V
Ø
-15V
COLL SWP
PARTIAL A2-BD DIAG ①
P486 P286
-40V UNREG
CS DISABLE
-12V
+12V
-30V
HORIZ AMP ATTEN
+40V UNREG
+5V
PARTIAL A3-BD DIAG ②
COLL VOLTS OUT
HORIZ AMP RETURN
GUARD
ERASE
CS RETURN
STEP AMP RETURN
STEP AMP OUT
STEP GEN
STEP AMP SHIELD
HORIZ AUTO POSITION
COLL SWP DISABLE
+12V
+30V
+5V
400V ENABLE
NOISY GND
CLEAN GND
-12V
VERT MAG
-30V
-90V
+40V
VERT SIGNAL
Ø +15V
Ø COMMON
Ø -15V
COLL SWEEP
A 3 C 4 D 5 E 6 F 7 H 8 J 9 K 10 L 11 M 12 N 13 P 14 R 15 S 16 T 17 U 18 V 19 W 20 21 Y 22 Z 24 BB

INTERCONNECTING DIAGRAM ④

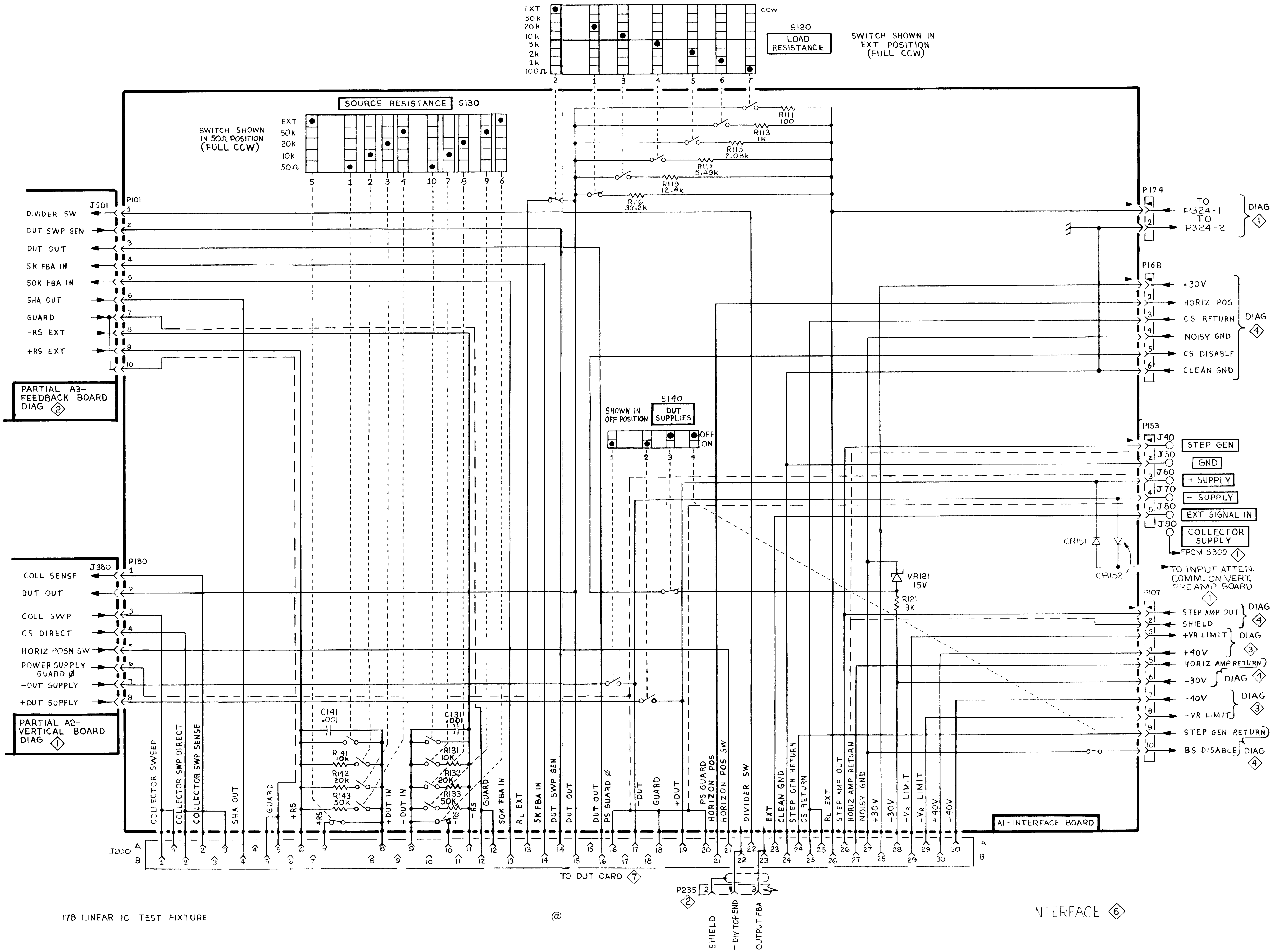
@


S300
FUNCTION
SWITCH SHOWN IN 1 POSITION (FULL CCW)
AMPLIFIER
OFFSET V CCW 1
+INPUT I 2
-INPUT I 3
CMRR 4
GAIN 5
+PSRR 6
-PSRR 7
±PSRR 8
+SUPPLY I 9
-SUPPLY I 10
COLLECTOR SUPPLY I 11
TO P264-2 DIAG ③
TO P264-4 DIAG ③
TO P235-1 DIAG ②
TO J201-6 DIAG ②
TO P264-5 DIAG ③
FROM SWP SIG DIAG ②
TO J201-8 DIAG ②
TO J201-9 DIAG ②
TO PIN-C DIAG ②
TO PIN-B DIAG ②
FROM PIN-D DIAG ②
FROM P380-1 DIAG ①
FROM P380-2 DIAG ①
TO P325-2 DIAG ①
TO P321-2 FROM PIN-E
TO P380-5 FROM PIN G
TO PIN-A DIAG ①
TO J380-6 DIAG ①
FROM P325-1 DIAG ①
TO J380-7 DIAG ①
TO PIN-D DIAG ①
FROM P360-6 DIAG ①
TO PIN-F DIAG ①
TO P324-1 FROM P324-2
TO R522
TO CR281 DIAG ②
TO R329
TO R309
-30V
R554
FROM R552
-30V
FROM R255 DIAG ②
+5V
FROM C263 DIAG ②
FROM R549 DIAG ③
TO R208 DIAG ②
FROM R271 DIAG ②
FROM F268 DIAG ②
FROM F236 DIAG ②
DIAG ③
DIAG ②
TO R300
FROM U340A-1
TO R305
SEE DIAG ① FOR DETAILS
SEE DIAG ①
* DOT ON LINES INDICATES SWITCH CLOSED BETWEEN POSITIONS
TO CR282
FROM R233
FROM R264
FROM R235
FROM R238
FROM R269
FROM R267
FROM R280
TO F236
TO F268
TO R305
FROM R321
FROM R323
FROM R322
TO R351
TO R300
FROM F-3
TO R333
FROM R302
FROM R301
TO R306
FROM R363
FROM R362
FROM R309
FROM R345
FROM R344
PARTIAL A3-FEEDBACK AMPLIFIER BOARD
PARTIAL A2-VERTICAL PREAMP BOARD
TO P235-1 DIAG ②
TO J201-6 DIAG ②
TO P321-2 DIAG ①
CCW
mV OR mA
µA OR µV
µA
nA
PicoA
SWITCH SHOWN IN mV POSITION (FULL CCW)
VERTICAL UNITS/DIV
S350

NOTES:

1. ▽2 ATTENUATOR COMMON
2. ▽ø POWER SUPPLY GUARD

FUNCTION/VERTICAL SWITCHES ⑤


EXT
50k
20k
10k
5k
2k
1k
100Ω
CCW
S120
LOAD RESISTANCE
SWITCH SHOWN IN EXT POSITION (FULL CCW)
2 1 3 4 5 6 7
SOURCE RESISTANCE S130
SWITCH SHOWN IN 50Ω POSITION (FULL CCW)
EXT
50k
20k
10k
50Ω
5 1 2 3 4 10 7 8 9 6
R111 100
R113 1k
R115 2.05k
R117 5.49k
R119 12.4k
R116 33.2k
J201
P101
DIVIDER SW
DUT SWP GEN
DUT OUT
5K FBA IN
50K FBA IN
SHA OUT
GUARD
-RS EXT
+RS EXT
PARTIAL A3-FEEDBACK BOARD DIAG ②
P124
TO P324-1
TO P324-2
DIAG ①
P168
+30V
HORIZ POS
CS RETURN
NOISY GND
CS DISABLE
CLEAN GND
DIAG ④
S140
SHOWN IN OFF POSITION
DUT SUPPLIES
OFF
ON
1 2 3 4
P153
J40
J50
J60
J70
J80
J90
STEP GEN
GND
+ SUPPLY
- SUPPLY
EXT SIGNAL IN
COLLECTOR SUPPLY
FROM S300 ①
CR151
CR152
TO INPUT ATTEN. COMM. ON VERT. PREAMP BOARD ①
VR121 15V
R121 3K
J380
P180
COLL SENSE
DUT OUT
COLL SWP
CS DIRECT
HORIZ POSN SW
POWER SUPPLY GUARD Ø
-DUT SUPPLY
+DUT SUPPLY
PARTIAL A2-VERTICAL BOARD DIAG ①
P107
STEP AMP OUT
SHIELD
DIAG ④
+VR LIMIT
+40V
DIAG ③
HORIZ AMP RETURN
-30V
DIAG ④
-40V
-VR LIMIT
DIAG ③
STEP GEN RETURN
BS DISABLE
DIAG ④
C141 .001
R141 10k
R142 20k
R143 50k
C131 .001
R131 10k
R132 20k
R133 50k
COLLECTOR SWEEP
COLLECTOR SWP DIRECT
COLLECTOR SWP SENSE
SHA OUT
GUARD
+RS
+RS
+DUT IN
-DUT IN
-RS
-RS
GUARD
50K FBA IN
RL EXT
5K FBA IN
DUT SWP GEN
DUT OUT
DUT OUT
PS GUARD Ø
-DUT
GUARD
+DUT
PS GUARD
HORIZON POS
HORIZON POS SW
DIVIDER SW
EXT
CLEAN GND
STEP GEN RETURN
CS RETURN
RL EXT
STEP AMP OUT
HORIZ AMP RETURN
NOISY GND
+30V
-30V
+VR LIMIT
-VR LIMIT
+40V
-40V
A1-INTERFACE BOARD
J200
A
B
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
TO DUT CARD ⑦
P235 ②
1 2 3
SHIELD
- DIV TOP END
OUTPUT FBA
@

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INTERFACE ⑥

DUT INTERFACE

⑥

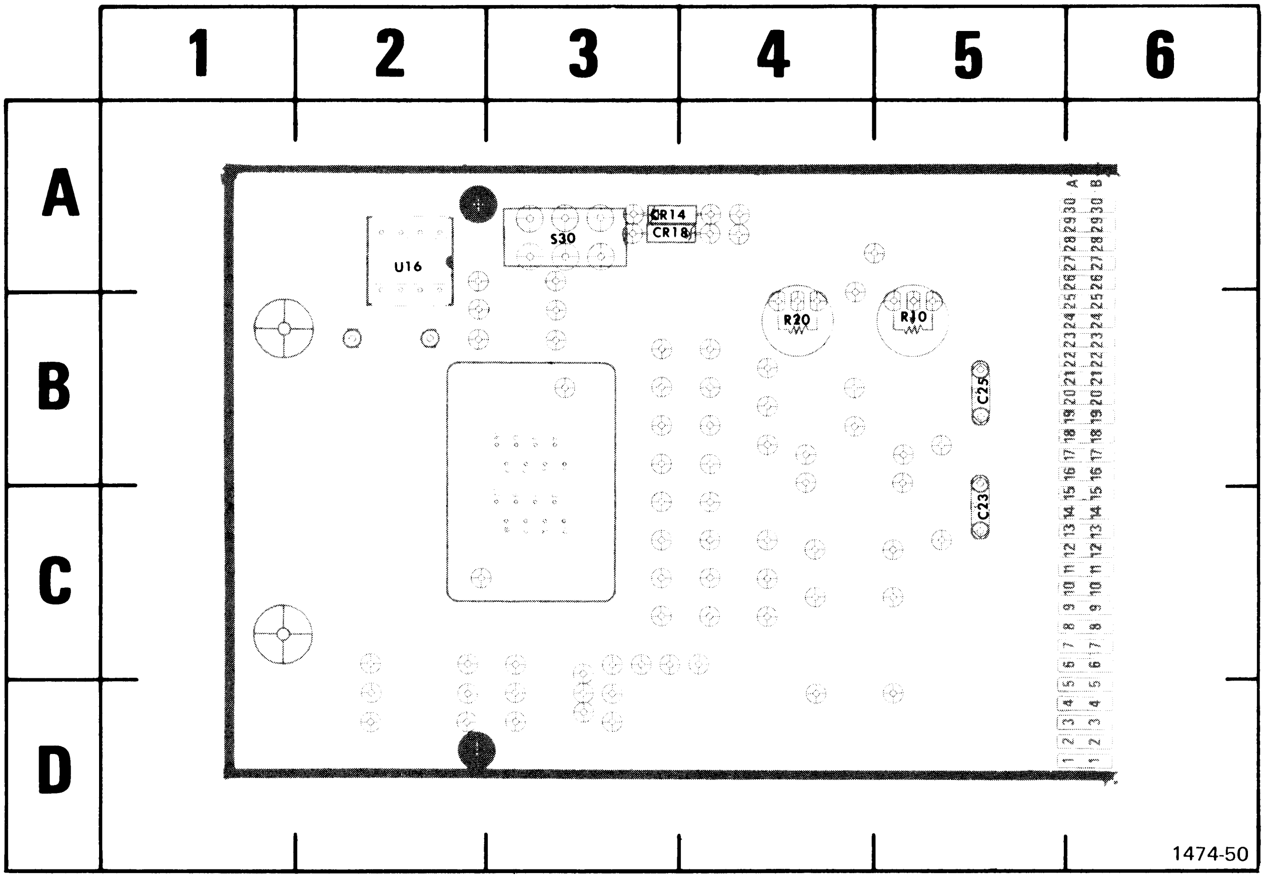
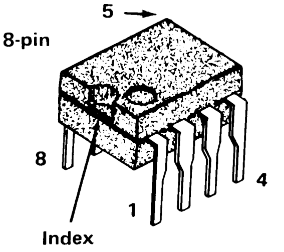
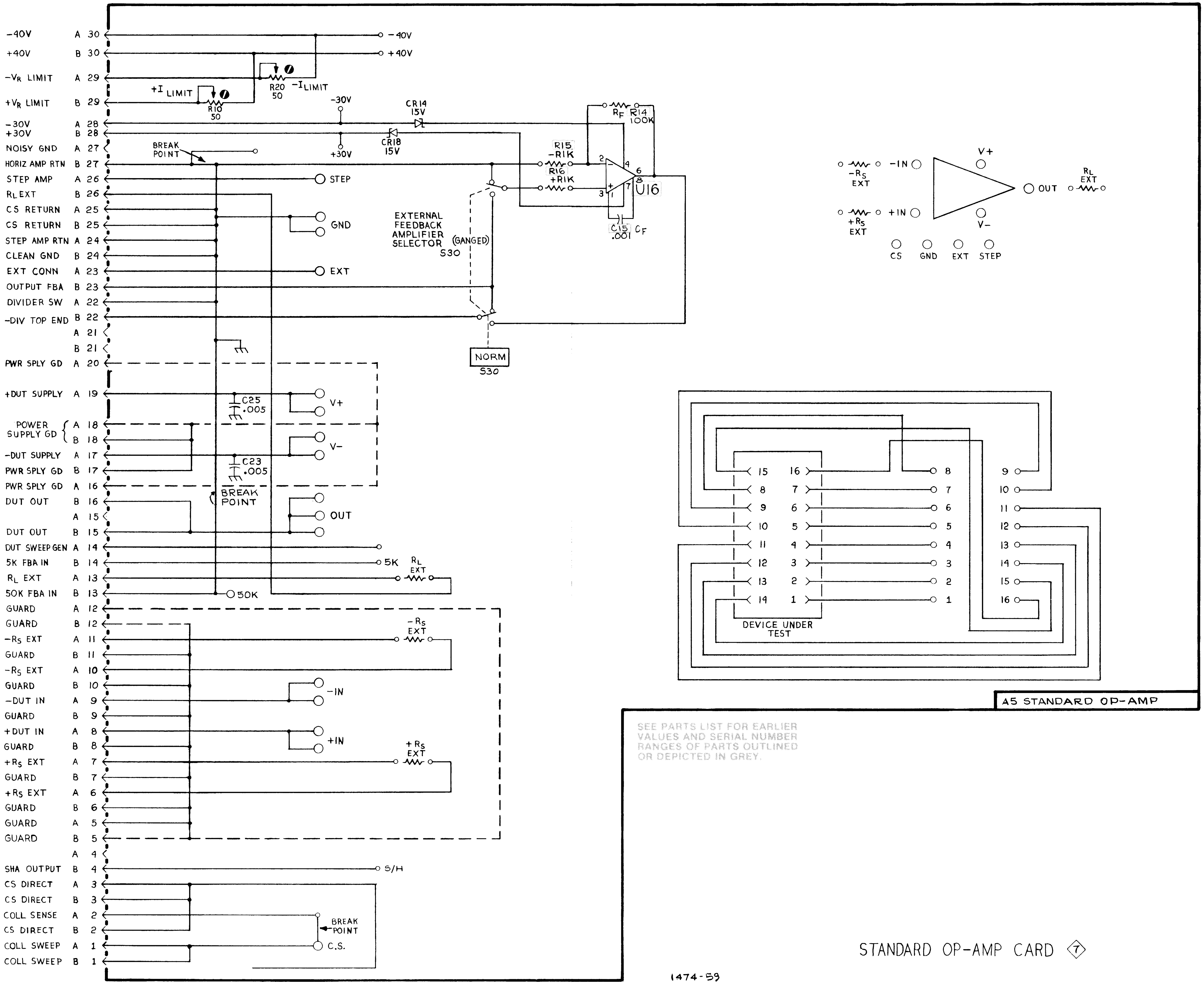

1
2
3
4
5
6
A
B
C
D
U16
S30
CR14
CR18
R20
R10
C25
C23
1474-50

Fig. 7-5. A5—Standard Op Amp Card circuit board.


5
8-pin
8
4
1
Index

INTEGRATED CIRCUITS

CKT NO	GRID LOC
C23	5C
C25	5B
CR14	3A
CR18	3A
R10	5B
R20	4B
S30	3A
U16	2A


-40V A 30
+40V B 30
-V_R LIMIT A 29
+V_R LIMIT B 29
-30V A 28
+30V B 28
NOISY GND A 27
HORIZ AMP RTN B 27
STEP AMP A 26
R_L EXT B 26
CS RETURN A 25
CS RETURN B 25
STEP AMP RTN A 24
CLEAN GND B 24
EXT CONN A 23
OUTPUT FBA B 23
DIVIDER SW A 22
-DIV TOP END B 22
A 21
B 21
PWR SPLY GD A 20
+DUT SUPPLY A 19
POWER SUPPLY GD A 18
B 18
-DUT SUPPLY A 17
PWR SPLY GD B 17
PWR SPLY GD A 16
DUT OUT B 16
A 15
DUT OUT B 15
DUT SWEEP GEN A 14
5K FBA IN B 14
R_L EXT A 13
50K FBA IN B 13
GUARD A 12
GUARD B 12
-R_S EXT A 11
GUARD B 11
-R_S EXT A 10
GUARD B 10
-DUT IN A 9
GUARD B 9
+DUT IN A 8
GUARD B 8
+R_S EXT A 7
GUARD B 7
+R_S EXT A 6
GUARD B 6
GUARD A 5
GUARD B 5
A 4
SHA OUTPUT B 4
CS DIRECT A 3
CS DIRECT B 3
COLL SENSE A 2
CS DIRECT B 2
COLL SWEEP A 1
COLL SWEEP B 1
-40V
+40V
+I LIMIT
R10 50
R20 50
-I LIMIT
-30V
+30V
CR14 15V
CR18 15V
BREAK POINT
R_F R14 100K
R15 -R1K
R16 +R1K
2 3 4 6 7 8 1
U16
C15 .001 C_F
STEP
GND
EXT
EXTERNAL FEEDBACK AMPLIFIER SELECTOR S30
(GANGED)
NORM S30
C25 .005
V+
C23 .005
V-
BREAK POINT
OUT
5K
R_L EXT
50K
-R_S EXT
-IN
+IN
+R_S EXT
S/H
BREAK POINT
C.S.
-R_S EXT
-IN
+R_S EXT
+IN
V+
V-
OUT
R_L EXT
CS GND EXT STEP
15 16
8 7
9 6
10 5
11 4
12 3
13 2
14 1
DEVICE UNDER TEST
8 7 6 5 4 3 2 1
9 10 11 12 13 14 15 16
A5 STANDARD OP-AMP

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

STANDARD OP-AMP CARD ⑦

1474-59
REV APR 1982

P.S. 6-3-73

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
  Detail Part of Assembly and/or Component
  Attaching parts for Detail Part
- - - * - - -
    Parts of Detail Part
    Attaching parts for Parts of Detail Part
- - - * - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000BK	STAUFFER SUPPLY	105 SE TAYLOR	PORTLAND, OR 97214
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OR 97005
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05129	KILO ENGINEERING COMPANY	2015 D	LA VERNE, CA 91750
05574	VIKING INDUSTRIES, INC.	21001 NORDHOFF STREET	CHATSWORTH, CA 91311
06090	RAYCHEM CORPORATION	300 CONSTITUTION DRIVE	MENLO PARK, CA 94025
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
09422	PLASTIC STAMPING CORPORATION	2216 W. ARMITAGE AVE.	CHICAGO, IL 60647
11535	LORANGER MFG. CORP.	12-38 CLARK ST.	WARREN, PA 16365
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
12360	ALBANY PRODUCTS CO., DIV. OF PNEUMO DYNAMICS CORPORATION	145 WOODWARD AVENUE	SOUTH NORWALK, CT 06586
19613	TEXTOOL PRODUCTS, INC.	1410 W PIONEER DRIVE	IRVING, TX 75061
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71159	BRISTOL SOCKET SCREW, DIV. OF AMERICAN CHAIN AND CABLE CO., INC.	P O BOX 2244, 40 BRISTOL ST.	WATERBURY, CT 06720
71279	CAMBRIDGE THERMIONIC CORP.	445 CONCORD AVE.	CAMBRIDGE, MA 02138
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
76854	OAK INDUSTRIES, INC., SWITCH DIV.	S. MAIN ST.	CRYSTAL LAKE, IL 60014
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
78471	TILLEY MFG. CO.	900 INDUSTRIAL RD.	SAN CARLOS, CA 94070
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81073	GRAYHILL, INC.	561 HILLGROVE AVE., PO BOX 373	LA GRANGE, IL 60525
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
88245	LITTON SYSTEMS, INC., USECO DIV.	13536 SATICOY ST.	VAN NUYS, CA 91409
97464	INDUSTRIAL RETAINING RING CO.	57 CORDIER ST.	IRVINGTON, NJ 07111

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-1	390-0359-00	B010100	B041599	1	PANEL,PLUG-IN:BOTTOM,0.063,AL	80009	390-0359-00
	390-0359-01	B041600		1	PANEL,PLUG-IN:BOTTOM,0.063,AL	80009	390-0359-01
					(ATTACHING PARTS)		
-2	211-0504-00			3	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
-3	211-0101-00			2	SCREW,MACHINE:4-40 X 0.25,100 DEG,FLH STL	83385	OBD
-4	211-0105-00			2	SCREW,MACHINE:4-40 X 0.188,100 DEG,FLH STL	83385	OBD
-5	210-0586-00			2	NUT,PL,ASSEM WA:4-40 X 0.25,STL	83385	OBD
					- - - * - - -		
-6	390-0227-02			1	PNL,PLUG-IN HSG:RIGHT SIDE	80009	390-0227-02
					(ATTACHING PARTS)		
-7	213-0146-00			4	SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
-8	211-0504-00			2	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-9	390-0228-01			1	CABINET SIDE:LEFT	80009	390-0228-01
					(ATTACHING PARTS)		
-10	213-0146-00			4	SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
-11	211-0504-00			2	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-12	337-1963-00			1	SHLD,ELECTRICAL:CIRCUIT CARD	80009	337-1963-00
					(ATTACHING PARTS)		
-13	211-0007-00			1	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-14	337-1962-00			1	SHLD,ELECTRICAL:CIRCUIT CARD	80009	337-1962-00
					(ATTACHING PARTS)		
-15	211-0007-00			1	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-16	337-1961-00			1	SHIELD,JACK:	80009	337-1961-00
-17	260-0247-00			1	SWITCH,PUSH:SPST,1A,115VAC	81073	30YY1009
					(ATTACHING PARTS)		
-18	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-19	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-20	210-0046-00			1	WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
					- - - * - - -		
-21	333-1731-00			1	PANEL,FRONT:	80009	333-1731-00
-22	366-0125-00			2	KNOB:KNURLED SECURING	80009	366-0125-00
	213-0004-00			2	. SETSCREW:6-32 X 0.188 INCH,HEX.SOC STL	74445	OBD
-23	210-0894-00			2	WASHER,NONMETAL:0.19 ID X 0.438" OD,PLSTC	09422	OBD
	162-0530-00	XB041680		FT	INSUL SLVG,ELEC:HT SHRINK,0.188 ID,PVC,BLK	06090	VERSAFIT
-24	384-0900-00			2	ROD,SECURING:0.188 DIA X 8.25 INCH LONG	80009	384-0900-00
					(ATTACHING PARTS)		
-25	354-0025-00			2	RING,RETAINING:0.181 INCH FREE ID	79136	5555-18
					- - - * - - -		
-26	136-0140-00			6	JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
					(ATTACHING PARTS)		
-27	210-0583-00			6	NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-28	210-0223-00	B010100	B041509	6	TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
	210-0223-01	B041510		6	TERMINAL,LUG:0.25 INCH DIA,SE,60 DEG BEND	86928	OBD
-29	210-0465-00			6	NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-30	210-0895-00			6	WSHR,SHOULDERED:0.375 OD X 0.105 INCH THK	80009	210-0895-00
					- - - * - - -		
-31	426-1024-00			1	FRAME PNL,CAB.:FRONT	80009	426-1024-00
					(ATTACHING PARTS)		
-32	211-0541-00			2	SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-33	366-1023-02			1	KNOB:GRAY--VAR	80009	366-1023-02
	213-0246-00			1	. SETSCREW:5-40 X 0.093 ITL BK OXD,HEX SKT	71159	OBD
-34	366-1037-00			1	KNOB:GRAY	80009	366-1037-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX SKT	000CY	OBD
-35	366-1207-00			2	KNOB:GRAY	80009	366-1207-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX SKT	000CY	OBD
-36	331-0373-00			1	DIAL,CONTROL:	05129	771-S-6
-37	366-1190-00			2	KNOB:GRAY	80009	366-1190-00
	213-0153-00			4	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX SKT	000CY	OBD
-38	366-1508-00			1	KNOB:GRAY,WITH SKIRT	80009	366-1508-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX SKT	000CY	OBD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-39	333-1770-00			1	PANEL,FUNCT SW:178	80009	333-1770-00
-40	352-0251-00			1	HOLDER,SCALE:2.14 INCH SQ,PLASTIC	80009	352-0251-00
-41	366-1501-00			1	KNOB:GRAY,WITH SKIRT	80009	366-1501-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX SKT	000CY	OBD
-42	----- -----			1	RES.,VARIABLE:(SEE R415 REPL)		
					(ATTACHING PARTS)		
-43	210-0590-00			2	NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-44	210-0012-00			1	WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
					- - - * - - -		
-45	384-1210-00			1	EXTENSION SHAFT:1.875 L X 0.125 INCH OD	80009	384-1210-00
					(ATTACHING PARTS)		
-46	376-0014-00			1	CPLG,SHAFT,FLEX:SST WIRE	76854	22675-001
					- - - * - - -		
-47	260-1529-00			1	SWITCH,ROTARY:SWEEP FREQUENCY(S420)	76854	5-18252-142
					(ATTACHING PARTS)		
-48	210-0590-00			1	NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-49	210-0978-00			1	WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
					- - - * - - -		
-50	----- -----			1	RES.,VARIABLE:(SEE R460/S460 REPL)		
-51	----- -----			1	RES.,VARIABLE:(SEE R565/S565 REPL)		
					(ATTACHING PARTS)		
-52	210-0583-00			2	NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-53	210-0940-00			2	WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
					- - - * - - -		
-54	----- -----			1	RES.,VARIABLE:(SEE R560 REPL)		
					(ATTACHING PARTS)		
-55	210-0046-00			1	WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
					- - - * - - -		
-56	----- -----			1	LAMP:(SEE DS441 REPL)		
					(ATTACHING PARTS)		
-57	348-0004-00			1	GROMMET,RUBBER:0.281 ID X 0.563 INCH OD	70485	763
					- - - * - - -		
-58	366-1489-37			1	PUSH BUTTON:GRAY PLASTIC	80009	366-1489-37
-59	426-0681-00			1	FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0681-00
-60	358-0029-05			2	BSHG,MACH THD:0.274 ID X 0.438"L,NP BRS	80009	358-0029-05
					(ATTACHING PARTS)		
-61	210-0590-00			2	NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-62	210-0012-00			2	WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
-63	210-0978-00			2	WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
					- - - * - - -		
-64	390-0358-00			1	CABINET,TOP:	80009	390-0358-00
-65	351-0380-00			2	GUIDE,CKT CARD:PLASTIC	80009	351-0380-00
					(ATTACHING PARTS)		
-66	211-0038-00			4	SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG	83385	OBD
					- - - * - - -		
-67	407-1296-00			1	BRACKET,ANGLE:INDICATOR LIGHTS	80009	407-1296-00
					(ATTACHING PARTS)		
-68	211-0030-00			2	SCREW,MACHINE:2-56 X 0.25"82 DEG,FLH STL	83385	OBD
-69	210-0001-00			2	WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
-70	210-0405-00			2	NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
					- - - * - - -		
-71	386-2569-00			1	DIFFUSER,LIGHT:SWITCH ILLUM,ACRYLIC	80009	386-2569-00
-72	352-0157-00			1	LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-73	200-0935-00			1	BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-74	386-2658-00			1	PLATE,TRIM:REAR	80009	386-2658-00
					(ATTACHING PARTS)		
-75	211-0504-00			3	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-76	352-0157-00			4	LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-77	200-0935-00			4	BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-78	378-0635-00			4	LENS,LIGHT:WHITE	80009	378-0635-00
-79	131-0942-00			1	CONTACT,ELEC:GROUNDING	80009	131-0942-00
					(ATTACHING PARTS)		
-80	213-0138-00			1	SCR,TPG,TF:4-24 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		

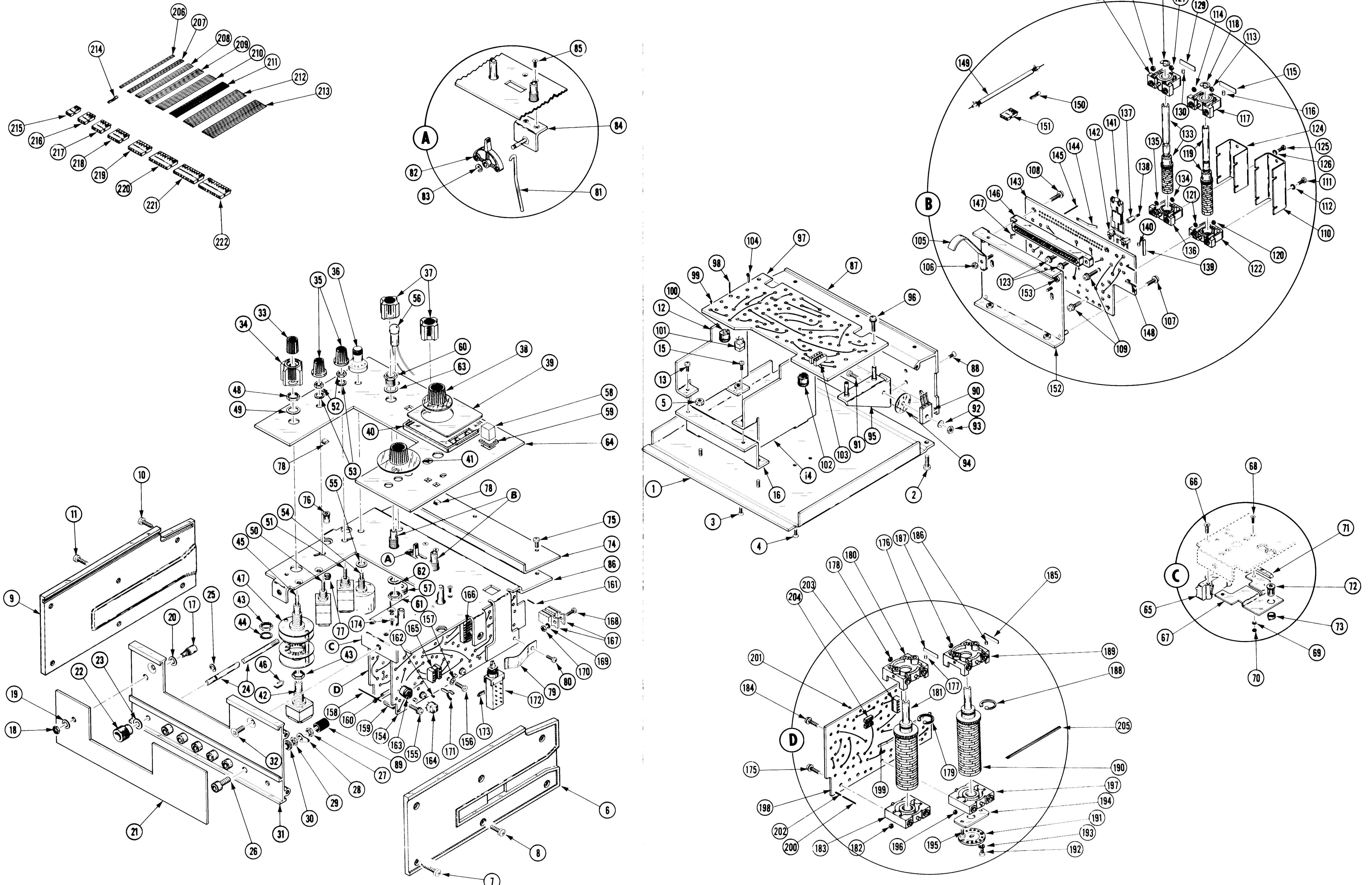
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-81	384-1202-00			1	EXTENSION SHAFT:LEVER SWITCH	80009	384-1202-00
-82	214-1770-00			1	LEVER,SLIDE SW:	80009	214-1770-00
					(ATTACHING PARTS)		
-83	354-0165-00			1	RING,RETAINING:0.114 FREE IDX 0.025 INCH	97464	1000-15
					- - - * - - -		
-84	407-1297-00			1	BRACKET,ANGLE:SWITCH,ALUMINUM	80009	407-1297-00
					(ATTACHING PARTS)		
-85	211-0101-00			2	SCREW,MACHINE:4-40 X 0.25,100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-86	441-1149-00			1	CHAS,ELEC EQPT:MAIN	80009	441-1149-00
-87	426-1023-00	B010100	B039999	1	FRAME SECT,CAB.:REAR	80009	426-1023-00
	426-1023-01	B040000		1	FRAME SECT,CAB.:REAR	80009	426-1023-01
					(ATTACHING PARTS)		
-88	211-0101-00			4	SCREW,MACHINE:4-40 X 0.25,100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-89	166-0353-00	B010100	B030929	1	SLEEVE,LOCKING:0.32 DIA X 0.57 INCH LONG	80009	166-0353-00
	166-0345-00	B030930		1	SLEEVE,LOCKING:0.32 DIA X 0.457 INCH L,NYLON	80009	166-0345-00
-90	----- -----			2	TRANSISTOR:(SEE Q484,Q584 REPL)		
					(ATTACHING PARTS)		
-91	211-0510-00			2	SCREW,MACHINE:6-32 X 0.375,PNH,STL,CD PL	83385	OBD
-92	210-0071-00			2	WASHER,SPR TNSN:0.146 ID X 0.323" OD,STL	78189	4706-05-01-0531
-93	210-0407-00			2	NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
					- - - * - - -		
-94	342-0136-00			2	INSULATOR,WSHR:0.812 OD X 0.0025 INCH THK	04713	OBD
-95	407-1298-00			2	BRACKET,ANGLE:CIRCUIT BOARD MTG	80009	407-1298-00
					(ATTACHING PARTS)		
-96	211-0116-00			4	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
-97	----- -----			1	CKT BOARD ASSY:POWER SUPPLY(SEE A4 REPL)		
-98	131-0589-00			6	. TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
	131-0608-00			54	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-99	136-0252-04			3	. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-100	136-0183-00			2	. SOCKET,PLUG-IN:3 PIN,ROUND	80009	136-0183-00
-101	136-0220-00	B010100	B030909	11	. SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
	136-0252-04	B030910		36	. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-102	136-0237-00			2	. SOCKET,PLUG-IN:8 CONTACT,ROUND	71785	133-98-12-062
-103	136-0514-00	B010100	B042389	3	. SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0727-00	B042390		3	. SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
	136-0403-00	XB040000		4	. SOCKET,PLUG-IN ELEK:MICRKT TEST(NOT SHOWN)	80009	136-0403-00
-104	214-0579-00			3	. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-105	214-0720-01			1	SPRING,GROUND:	80009	214-0720-01
					(ATTACHING PARTS)		
-106	210-0586-00			1	NUT,PL,ASSEM WA:4-40 X 0.25,STL	83385	OBD
					- - - * - - -		
	672-0070-00			1	CKT BOARD ASSY:CAM SWITCH	80009	672-0070-00
					(ATTACHING PARTS)		
-107	211-0116-00			2	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
-108	211-0154-00	B010100	B049999	2	SCR,ASSEM WSHR:4-40 X 0.562 INCH,PNH BRS	83385	OBD
	211-0152-00	B050000		2	SCR,ASSEM WSHR:4-40 X 0.625 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	CKT BOARD ASSY CAM SWITCH INCLUDES:		
	263-1026-00			1	. SW CAM ACTR AS:SOURCE RESISTANCE	80009	263-1026-00
					(ATTACHING PARTS)		
-109	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. ACTUATOR ASSY INCLUDES:		
-110	200-0995-00			1	. . COVER,CAM SW:	80009	200-0995-00
					(ATTACHING PARTS)		
-111	211-0022-00			2	. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-112	210-0001-00			2	. . WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
					- - - * - - -		
-113	210-0405-00			1	. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
-114	210-0406-00			2	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-115	214-1126-00			1	. . SPRING,FLAT:GOLD COLORED	80009	214-1126-00
	214-1126-02			1	. . SPRING,FLAT:RED COLORED	80009	214-1126-02
-116	214-1127-00			1	. . ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-117	401-0058-00			1	. . BEARING,CAM SW:FRONT	80009	401-0058-00
					(ATTACHING PARTS)		
-118	354-0219-00			1	. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
					- - - * - - -		
-119	105-0460-00			1	. . ACTUATOR,CAM SW:	80009	105-0460-00
-120	210-0405-00			1	. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
-121	210-0406-00			2	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-122	401-0061-00			1	. . BEARING,CAM SW:REAR	80009	401-0061-00
	263-1027-00			1	. CAM SW ACTR AS:LOAD RESISTANC	80009	263-1027-00
					(ATTACHING PARTS)		
-123	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. ACTUATOR ASSY INCLUDES:		
-124	200-1033-00			1	. . COVER,CAM SW:7 ELEMENTS	80009	200-1033-00
					(ATTACHING PARTS)		
-125	211-0022-00			2	. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-126	210-0001-00			2	. . WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
					- - - * - - -		
-127	210-0405-00			1	. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
-128	210-0406-00			2	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-129	214-1126-00			1	. . SPRING,FLAT:GOLD COLORED	80009	214-1126-00
	214-1126-02			1	. . SPRING,FLAT:RED COLORED	80009	214-1126-02
-130	214-1127-00			1	. . ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-131	401-0058-00			1	. . BEARING,CAM SW:FRONT	80009	401-0058-00
					(ATTACHING PARTS)		
-132	354-0219-00			1	. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
					- - - * - - -		
-133	105-0459-00			1	. . ACTUATOR,CAM SW:	80009	105-0459-00
-134	210-0405-00			1	. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
-135	210-0406-00			2	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-136	401-0061-00			1	. . BEARING,CAM SW:REAR	80009	401-0061-00
	105-0467-00			1	. ACTUATOR,SWITCH:SLIDE ASSY,ON-OFF(S140)	80009	105-0467-00
-137	376-0142-00			1	. . ADPT,SHAFT,CPLG:SLIDE TO SHAFT	80009	376-0142-00
					(ATTACHING PARTS)		
-138	213-0048-00			1	. . SETSCREW:4-40 X 0.125 INCH,HEX SOC STL	74445	OBD
					- - - * - - -		
-139	214-1126-01			2	. . SPRING,FLAT:0.7 X 0.125,CU BE GRN CLR	80009	214-1126-01
-140	214-1127-00			2	. . ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-141	105-0478-00			1	. . ACTUATOR,SWITCH:	80009	105-0478-00
-142	351-0355-00			1	. . GUIDE,SLIDE SW:	80009	351-0355-00
-143	----- -----			-	. CKT BOARD ASSY:INTERFACE(SEE A1 REPL)		
-144	131-0604-00			21	. . CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-145	131-0608-00			23	. . TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	131-0787-00			8	. . CONTACT,ELEC:0.64 INCH LONG	22526	47359
-146	131-1228-00			1	. . CONNECTOR,RCPT,:CKT BD,30/60 CONTACTS	05574	000201-5421
-147	214-1458-00			1	. . KEY,CONN PLZN:CKT BOARD	05574	091-0071-000
-148	131-1261-00			10	. . CONTACT,ELEC:F-SHAPED	00779	1-380953-0
-149	175-0072-00			FT	. CABLE,RF:2 CONDUCTOR	80009	175-0072-00
-150	131-0707-00			3	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	47439
-151	352-0161-05			1	. CONN BODY,PL,EL:3 WIRE GREEN	80009	352-0161-05
-152	386-2570-00			1	SUPPORT,CKT BD:INTERFACE	80009	386-2570-00
					(ATTACHING PARTS)		
-153	210-0586-00			2	NUT,PL,ASSEM WA:4-40 X 0.25,STL	83385	OBD
					- - - * - - -		
-154	----- -----			1	CKT BOARD ASSY:FEEDBACK AMPL(SEE A3 REPL)		
					(ATTACHING PARTS)		
-155	211-0116-00			6	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
-156	211-0168-00			2	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	12360	OBD
-157	210-1002-00			2	WASHER,FLAT:0.125 ID X 0.25 INCH OD,BRS	12327	OBD
					- - - * - - -		
	----- -----			-	CKT BOARD ASSY INCLUDES:		
-158	131-0593-00			7	. CONTACT,ELEC:1.15 INCH LONG	22526	47354
-159	352-0274-00			1	. HOLDER,TERMINAL:FOR 8 SQUARE PINS	80009	352-0274-00
-160	131-0604-00			24	. CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-161	131-0608-00			19	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-162	136-0252-04			6	. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-163	136-0220-00	B010100	B030909	9	. SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
	136-0252-04	B030910		27	. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-164	136-0237-00			1	. SOCKET,PLUG-IN:8 CONTACT,ROUND	71785	133-98-12-062
-165	136-0514-00	B010100	B042389	1	. SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0727-00	B042390		1	. SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-166	136-0499-10			1	. CONNECTOR,RCPT,:10 CONTACT	00779	4-380949-0
-167	----- -----			2	. TRANSISTOR:(SEE Q546,Q548 REPL)		
					(ATTACHING PARTS)		
-168	211-0008-00			2	. SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
-169	210-0004-00			2	. WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	000BK	OBD
-170	210-0406-00			2	. NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
					- - - * - - -		
-171	344-0154-00			4	. CLIP,ELECTRICAL:FUSE,CKT BD MT	80009	344-0154-00
-172	260-1310-00			1	. SWITCH,PUSH:4PDT MOMENTARY	71590	2KAA0010000-437
-173	361-0384-00			2	. SPACER,PB SW:0.133 INCH LONG	80009	361-0384-00
	672-0413-00			1	CKT BOARD ASSY:CAM SWITCH		
					(ATTACHING PARTS)		
-174	211-0030-00			4	SCREW,MACHINE:2-56 X 0.25"82 DEG,FLH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
	263-1024-00			1	. SW CAM ACTR AS:VERTICAL UNITS/DIV	80009	263-1024-00
					(ATTACHING PARTS)		
-175	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. ACTUATOR ASSY INCLUDES:		
-176	214-1139-02			1	. . SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	214-1139-03			1	. . SPRING,FLAT:RED COLORED	80009	214-1139-03
-177	214-1127-00			2	. . ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-178	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
	105-0482-00			1	. . STOP,DETENT:	80009	105-0482-00
-179	354-0391-00			1	. . RING,RETAINING:0.395"FREE ID X 0.025" STL	97464	3100-43-CD
-180	401-0081-01			1	. . BEARING,CAM SW:WITH THREADED INSERTS	80009	401-0081-01
-181	105-0461-00			1	. . ACTUATOR,CAM SW:	80009	105-0461-00
-182	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-183	401-0115-00			1	. . BEARING,CAM SW:CENTER	80009	401-0115-00
	263-1025-00			1	. SW CAM ACTR AS:FUNCTION	80009	263-1025-00
					(ATTACHING PARTS)		
-184	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. ACTUATOR ASSY INCLUDES:		
-185	214-1139-03			2	. . SPRING,FLAT:RED COLORED	80009	214-1139-03
-186	214-1127-00			2	. . ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-187	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-188	354-0391-00			1	. . RING,RETAINING:0.395"FREE ID X 0.025" STL	97464	3100-43-CD
-189	401-0081-01			1	. . BEARING,CAM SW:WITH THREADED INSERTS	80009	401-0081-01
-190	105-0462-00			1	. . ACTUATOR,CAM SW:	80009	105-0462-00
-191	263-0519-00			1	. . SW SECTION,RTRY:FUNCTION	76854	4-2542-619
					(ATTACHING PARTS)		
-192	211-0181-00			2	. . SCREW,MACHINE:2-56 X 0.375 INCH,PNH BRS	12360	OBD
-193	210-0053-00			2	. . WASHER,LOCK:INTL,0.092 ID X 0.175"OD,STL	83385	OBD
					- - - * - - -		
-194	386-2877-00			1	. . PLATE,SW MTG:FUNCTION	80009	386-2877-00
					(ATTACHING PARTS)		
-195	211-0022-00			2	. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-196	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-197	401-0146-01			1	. . BEARING,CAM SW:CENTER	80009	401-0146-01
-198	----- -----			1	. CKT BOARD ASSY:VERT PREAMPL(SEE A2 REPL)		
-199	131-0604-00			30	. . CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-200	131-0608-00			10	. . TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-201	136-0252-04			10	. . SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-202	136-0327-01	B010100	B030699	7	. . SOCKET,PIN TERM:0.067 INCH DIA	00779	86281-2
	136-0263-04	B030700		7	. . SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont				
1-203	136-0499-08			1	. . CONNECTOR,RCPT,:8 CONTACT	00779	30380949-8
-204	136-0514-00	B010100	B042389	2	. . SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0727-00	B042390		2	. . SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
	136-0263-03	B010100	B030699	7	. . SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	00779	85864-2
	136-0263-04	B030700		7	. . SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-205	175-0825-00			FT	. WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
-206	175-0825-00			FT	WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
-207	175-0826-00			FT	WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
-208	175-0827-00			FT	CABLE,SP,ELEC:4,26 AWG,STRD.PVC JKT,RBN	08261	SS04267(1061)0C
-209	175-0828-00			FT	WIRE,ELECTRICAL:5 WIRE RIBBON	08261	SS-0526-710610C
-210	175-0829-00			FT	WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
-211	175-0831-00			FT	WIRE,ELECTRICAL:8 WIRE RIBBON	08261	SS-0826-710610C
-212	175-0832-00			FT	WIRE,ELECTRICAL:9 WIRE RIBBON	08261	SS-0926(1061)0C
-213	175-0833-00			FT	WIRE,ELECTRICAL:10 WIRE RIBBON	08261	SS-1026-7
-214	131-0707-00			109	CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	47439
-215	352-0169-02			1	CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	352-0169-04			2	CONN BODY,PL,EL:2 WIRE YELLOW	80009	352-0169-04
	352-0169-05			2	CONN BODY,PL,EL:2 WIRE GREEN	80009	352-0169-05
-216	352-0161-09			1	CONN BODY,PL,EL:3 WIRE WHITE	80009	352-0161-09
-217	352-0162-01			1	CONN BODY,PL,EL:4 WIRE BROWN	80009	352-0162-01
-218	352-0163-03			1	CONN BODY,PL,EL:5 WIRE ORANGE	80009	352-0163-03
-219	352-0164-00			2	CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00
	352-0164-03			1	CONN BODY,PL,EL:6 WIRE ORANGE	80009	352-0164-03
	352-0164-04			2	CONN BODY,PL,EL:6 WIRE YELLOW	80009	352-0164-04
	352-0164-08			2	CONN BODY,PL,EL:6 WIRE GRAY	80009	352-0164-08
-220	352-0166-06			2	CONN BODY,PL,EL:8 WIRE BLUE	80009	352-0166-06
-221	352-0167-02			1	CONN BODY,PL,EL:9 WIRE RED	80009	352-0167-02
-222	352-0168-07			2	CONN BODY,PL,EL:10 WIRE VIOLET	80009	352-0168-07

FIG. 1 EXPLODED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178 LINEAR IC CURVE TRACER

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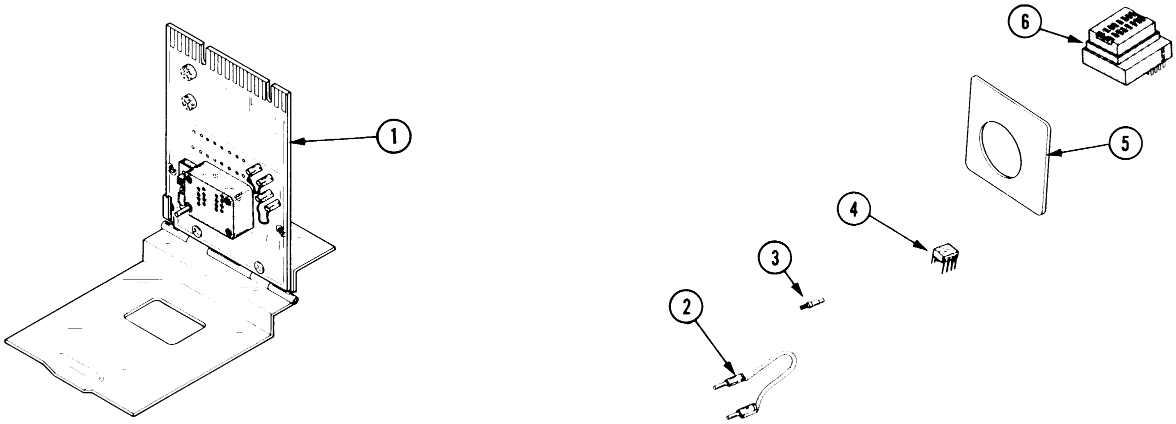
STANDARD ACCESSORIES



Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
-1	013-0149-00	B010100	B030709	1	ADAPTER,CKT BD:OP AMPLIFIER	80009	013-0149-00
	013-0149-01	B030710	B042069	1	ADAPTER,CKT BD:OP AMPLIFIER	80009	013-0149-01
	013-0149-02	B042070		1	ADAPTER,CKT BD:OP AMPLIFIER	80009	013-0149-02
-2	012-0200-00			10	. LEAD,TEST:2.0 L	71279	3705-1-0312
-3	131-1497-00	B010100	B030709	12	. CONTACT,ELEC:0.04 DIA PIN 1 END	88245	15409
	131-1497-00	B030710		14	. CONTACT,ELEC:0.04 DIA PIN 1 END	88245	15409
	136-0388-00	XB030710		1	. SOCKET,PIN TERM:U/W 0.04 DIA PIN	71279	450-3704-01-0300
-4	156-0067-00			1	. MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	02735	85145
-5	333-1770-00			1	PANEL,FUNCT SW:	80009	333-1770-00
-6	136-0442-00			1	SOCKET,PLUG-IN:MICROCIRCUIT,16 CONTACT	11535	2748-161-1221
	070-1978-00			1	MANUAL,TECH:SERVICE	80009	070-1978-00
	070-1977-00			1	MANUAL,TECH:OPERATORS(NOT SHOWN)	80009	070-1977-00

OPTIONAL ACCESSORIES

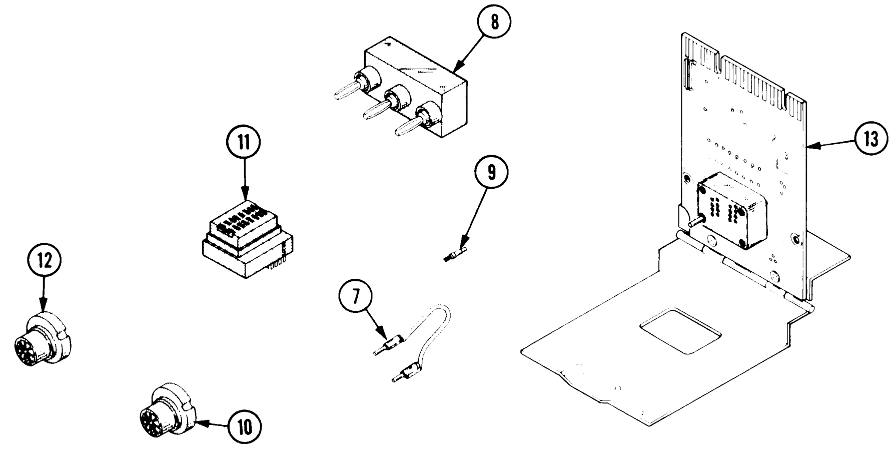


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
-7	012-0200-00			1	LEAD,TEST:2.0 L	71279	3705-1-0312
-8	013-0070-01			1	ADAPTER,TEST:3 TERMINAL,TRANSISTOR	80009	013-0070-01
-9	131-1497-00			1	CONTACT,ELEC:0.04 DIA PIN 1 END	88245	15409
-10	136-0441-00			1	SOCKET,PLUG-IN:XSTR,10 LEAD TO TO-5	11535	2767-101-1221/SA
-11	136-0443-00			1	SOCKET,PLUG-IN:MICROCIRCUIT,14 CONTACT	11535	2748-141-1221SAT
-12	136-0444-00			1	SOCKET,PLUG-IN:XSTR,10 LEAD TO TO-5	11535	27678101221/SATP
-13	013-0150-01	B010100	B042069	1	ADAPTER,CKT BD:OPTIONAL AMPL HARDWARE	80009	013-0150-01
	013-0150-02	B042070		1	ADAPTER,CKT BD:OPTIONAL AMPL HARDWARE	80009	013-0150-02
	013-0147-00			1	TEST UNIT,RGLTR:3 TERM POS	80009	013-0147-00
	013-0148-00			1	TEST UNIT,RGLTR:NEGATIVE REGULATOR	80009	013-0148-00